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TECHNICAL APPENDIX ON MUNICIPAL WASTE-SOURCE EVALUATIONS, WATER QUALITY INVESTIGATIONS IN THE SOUTH PLATTE RIVER BASIN, COLORADO, 1971-72

NATIONAL FIELD INVESTIGATIONS CENTER

JUNE 1972

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ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

TECHNICAL APPENDIX
ON
MUNICIPAL WASTE-SOURCE
EVALUATIONS

WATER QUALITY INVESTIGATIONS
IN THE
SOUTH PLATTE RIVER BASIN, COLORADO
1971-72

NATIONAL FIELD INVESTIGATIONS CENTER-DENVER
AND
REGION VIII DENVER, COLORADO

JUNE 1972

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GLOSSARY OF TERMS

BOD - Biochemical Oxygen Demand, 5-Day

COD - Chemical Oxygen Demand

DO - Dissolved Oxygen

MPN - Most Probable Number

NH_3N - Ammonia Nitrogen

NO_2-NO_3-N - Nitrite Nitrate Nitrogen

P - Phosphorus

PO_4 - Orthophosphate

SS - Suspended Solids

TOC - Total Organic Carbon

RM - river mileage (e.g. 311.1/6.7) with first number denoting distance from mouth of the South Platte River to the confluence with a tributary stream, and second value indicating distance upstream of mouth of the tributary stream

cfs - flow rate given in cubic feet per second

gpm - flow rate given in gallons per minute

mgd - flow rate given in million gallons per day

mg/l - concentration given in milligrams per liter

µmhos/cm - unit of specific conductance (mho -- the inverse of the standard unit of electrical resistance, the ohm) measured over a 1-centimeter distance, conventionally made at 25°C

Municipal waste - combination of domestic and industrial wastewaters discharged to waterways by governmental units, such as cities or sanitary districts

INTRODUCTION

This appendix summarizes information concerning the municipal waste sources investigated in the South Platte River Basin and supplements the main report entitled, "Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72."

Twenty-three municipal plants were investigated in order to determine both the adequacy of present treatment practices and the waste loads being discharged. Included in this appendix is a report on each municipal wastewater treatment facility evaluated, with the exception of the Metropolitan Denver Sewage Disposal District #1 plant (Metro) and the Greeley Wastewater Treatment Plant. These plants are discussed in separate reports entitled, "Effects of Waste Discharges on Water Quality of the South Platte River, Denver Metropolitan Area" and "Effects of Waste Discharges on Water Quality of the Cache la Poudre and South Platte Rivers, Greeley Area."

The format used for presenting specific information on each municipal plant is as follows:

A. Introduction--includes background information and contacts;

B. Waste Treatment Facilities -- includes type of system, number and sizes (where information was available) of units, and a flow diagram;

C. Discussion of Plant Evaluation and Findings--includes information on evaluation procedure, data from chemical and bacteriological analyses, visual observations, plant efficiencies, etc.;

D. Summary and Conclusions; and

E. Recommendations

The waste treatment requirements recommended for a plant were based on the following factors:

1. Expected low flows in the receiving stream, as determined by an examination of available flow records;

2. Compliance with applicable water quality standards, e.g., dissolved oxygen criteria;

3. Pretreatment of industrial wastes to levels comparable with that expected of domestic sewage (250 mg/l BOD and SS) prior to discharge to a municipal treatment plant; and

4. Waste load limits consistent with those being established for industries under the Refuse Act Permit Program.

ARVADA WASTEWATER TREATMENT PLANT
5555 WEST 56TH AVENUE
ARVADA, COLORADO

A. INTRODUCTION

The Arvada wastewater treatment plant serves about 50,000 people. It is located on Ralston Creek (RM 311.1/6.7/0.2), a tributary of Clear Creek [Figure 1]. The operating staff includes a superintendent, a chief operator, and two plant operators. The plant is manned eight hours/day, seven days/week. The budget for 1970 was $338,000 of which $76,000 was for the collection system, $41,000 for operation of the Arvada plant, and the remainder for services provided by the Metropolitan Denver Sewage Disposal District No. 1 plant (Metro) to which Arvada was connected in 1967. Approximately 1.1 mgd is treated by the Arvada plant with the remainder diverted to Metro.

Primary facilities (clarifier and digester) were originally constructed in 1930 using Works Progress Administration (WPA) funds. In 1953, a trickling filter and secondary clarifier were added: chlorination facilities were added in 1967.

In 1964 this plant served a population of 36,000 with an average flow of 3.5 mgd,[1/] far in excess of the hydraulic capacity of the plant. Approximately one-third of the flow was treated with the effluent discharged to Ralston Creek. The remaining 2.4 mgd was discharged without treatment to Clear Creek. No disinfection was provided. As a result of the 1964 studies, it was recommended that: a) the BOD of the discharge not exceed 30 mg/l after January 1, 1967; b) disinfection be provided; c) additional operating staff be provided (in 1964, the plant had one operator and one laborer); and d) laboratory analyses be routinely performed (none were run at the time of the 1964 survey).

The plant was evaluated by personnel of the National Field Investigations Center - Denver, August 11-14, 1971, to ascertain improvements in plant operation since the South Platte River Basin Project studies and to determine the waste loads discharged.

Richard Thomas, Arvada City Manager, and Delmar Dunlap, Chief Operator, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The Arvada plant has a hydraulic capacity of 1.2 mgd and an organic capacity of 2,500 lb/day (250 mg/l BOD at 1.2 mgd). Flow into the plant is normally maintained at approximately 1.1 mgd with all flow in excess of this amount diverted to Metro. Principal components of the plant are [Figure 1]:

1. Preliminary treatment -- bar screen, grit chamber, and comminutor.
2. Primary treatment -- clarifier (35 ft in diameter, 7 ft side water depth (SWD)). Detention time at design flow is about one hour.
3. Secondary treatment -- one high rate trickling filter (78 ft in diameter, 4 ft 8 in of rock). One clarifier, same size as the primary.
4. Disinfection -- chlorine contact chamber with 16 minutes detention time at design flow.
5. Digestion -- two-stage anaerobic designed for a solids loading of 1,680 lb/ft^2. The primary digester is 30 ft in diameter

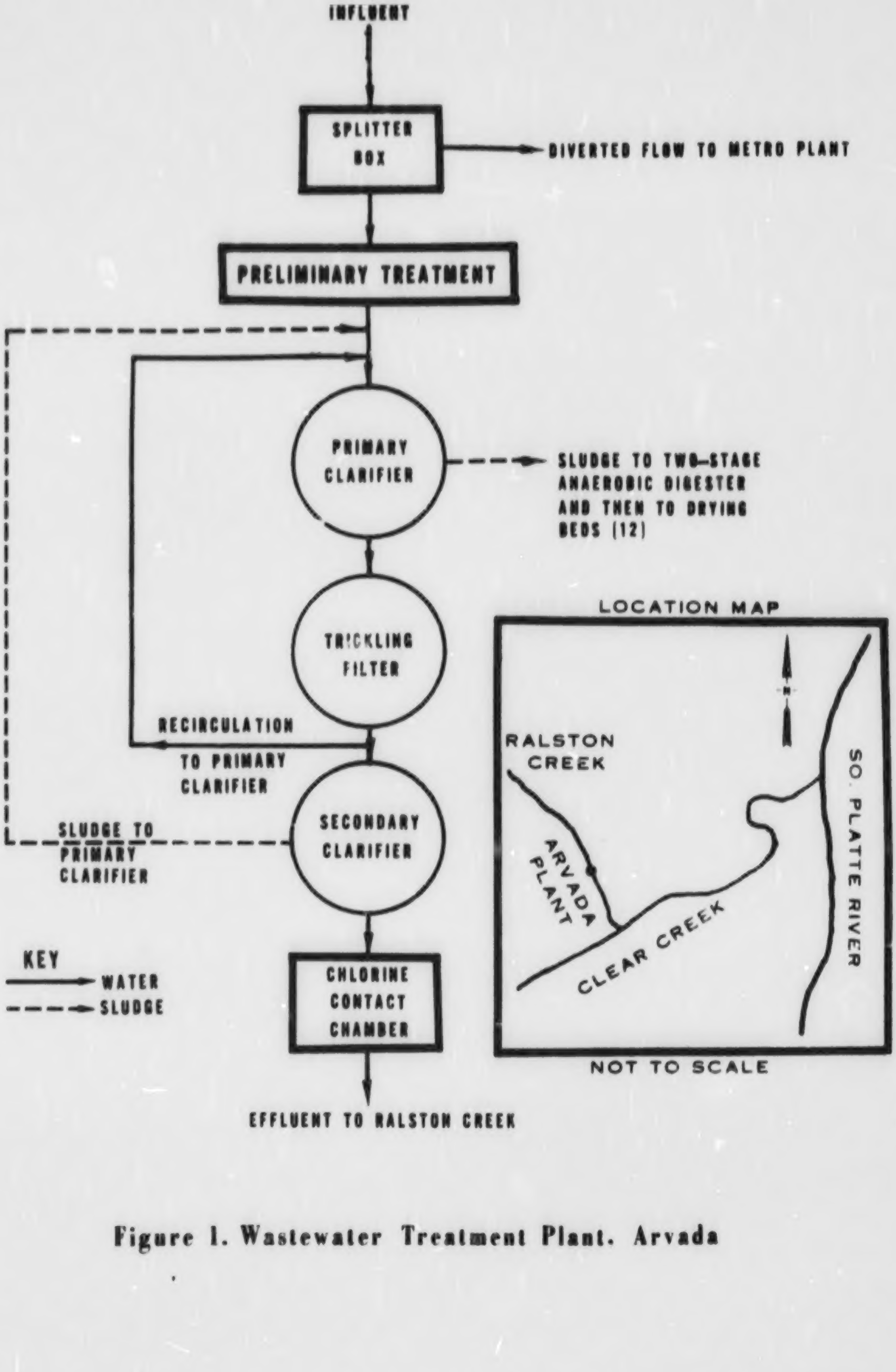
INFLUENT
SPLITTER BOX
DIVERTED FLOW TO METRO PLANT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTER AND THEN TO DRYING BEDS (12)
TRICKLING FILTER
RECIRCULATION TO PRIMARY CLARIFIER
SECONDARY CLARIFIER
SLUDGE TO PRIMARY CLARIFIER
KEY
WATER
SLUDGE
CHLORINE CONTACT CHAMBER
EFFLUENT TO RALSTON CREEK
LOCATION MAP
N
RALSTON CREEK
ARVADA PLANT
CLEAR CREEK
SO. PLATTE RIVER
NOT TO SCALE

Figure 1. Wastewater Treatment Plant. Arvada

with center depth of 24.5 ft. The secondary digester is 30 ft in diameter with 21 ft SWD. Sludge is wasted to 12 drying beds (eight are 25 ft by 50 ft; four are 20 ft by 40 ft).

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

An in-plant evaluation of the Arvada plant commenced on August 11, 1971. Three 24-hr composites* were collected of the influent and the effluent after chlorination and analyzed for BOD, TOC, and solids. The pH, conductivity, and temperature were measured every two hours and grab samples of the effluent were collected periodically for bacteriological analyses and for measurement of chlorine residual.

Analytical data indicate that the BOD removal efficiencies ranged from 81 to 90 percent [Table 1]. Disinfection was adequate as evidenced by the low fecal coliform bacteria densities [Table 2].

Operation and maintenance of the Arvada plant has improved markedly since the 1964 studies.1/ The plant effectively treats 1.1 mgd and most importantly, the raw sewage discharge has been eliminated by diverting all flows in excess of the design capacity to Metro. Additional personnel have been employed and laboratory tests (BOD and solids -- settleable and suspended) are performed twice weekly on the influent and effluent; total solids and pH of the digested sludge are measured when drawn; the chlorine residual of the effluent is measured daily. Moreover, the DO of the receiving water is measured upstream and downstream from the plant discharge twice weekly.

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* Composites were made up of grab samples collected each hour and composited on a flow weighted basis from measurements at the headworks.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
ARVADA WASTEWATER TREATMENT FACILITY
AUGUST 11-14, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	Range
Flow (mgd)			1.06-1.10	1.09	
pH (S.U.)	6.2-7.8		6.8-7.6		
Temperature (°C)	18.5-23		19-25		
Conductivity (umhos/cm)	520-1,100		575-1,200		
BOD (mg/1)	150-230	190	15-44	29	81-90
TOC (mg/1)	78-150	105	28-37	31	64-75
Total Solids (mg/1)	670-720	690	590-620	600	
SS (mg/1)	90-190	147	40-60	50	55-69
Settleable Solids (ml/1)	4.0-4.5	4.3	Trace		

---

[a] Analyses for BOD, TOC, total solids, suspended solids, and settleable solids were performed on composite samples.

TABLE 2

BACTERIOLOGICAL RESULTS
ARVADA WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
August 11, 1971	0840	7,300	400	1.4
	1135	<100	<20	1.2
	1320	3,100	16	1.2
August 12, 1971	1030	1,900	36	1.3
	1400	1,600	38	1.4
	1910	53,000	72	1.0
August 13, 1971	0640	240	26	1.6
	1510	500	16	1.7

On the basis of data collected by officials of Arvada and Metro, there appears to be an infiltration problem in the Arvada collection system. For example, the influent BOD of samples, collected January 1 to 7, 1971, contained an average of 266 mg/l; an average flow of 2.9 mgd was diverted to Metro. Samples collected June 29-July 5, 1971, contained 160 mg/l BOD and the average flow diverted was 3.9 mgd.

D. SUMMARY AND CONCLUSIONS

The Arvada plant effectively treats 1.1 mgd of wastewater and discharges an adequately disinfected waste to Ralston Creek. However, this flow represents only about 25 percent of the total flow received at the plant, thus continued operation of the plant for this small portion does not appear justified.

E. RECOMMENDATIONS

It is recommended that the operation of the Arvada plant be discontinued and all wasteflow diverted to the Metro system.

F. REFERENCES

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin,* U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December, 1964. Appendix B.

BAKER WATER AND SANITATION DISTRICT
WASTEWATER TREATMENT FACILITY
64TH AVENUE AND PECOS STREET
DENVER, COLORADO

A. INTRODUCTION

The Baker treatment plant serves a population of approximately 18,000. The high-rate trickling filter process is used with the effluent being discharged into Clear Creek (RM 311.1/3.4) a tributary of the South Platte River [Figure 1]. About one mgd of wastewater is treated by the plant with the remainder, approximately 0.8 mgd, diverted to the Metropolitan Denver Sewage Disposal District No. 1 plant (Metro). The Baker plant was constructed in 1957 (design capacity 1.0 mgd) and chlorination facilities added in 1965. Total cost of the plant was $331,000.

The plant is staffed by a chief operator and a relief operator and is manned eight hours/day, seven days/week. The annual operating budget is approximately $68,000 of which $45,000 is for services provided by Metro and $23,000 is for plant operation.

An in-plant evaluation in 1964[1] showed that the plant was serving 17,500 and was staffed by only one operator. The effluent BOD average was 150 mg/1 and raw sewage was being bypassed. As a result of the 1964 studies, it was recommended that the plant employ an additional operator and one laborer and that the effluent BOD not exceed 30 mg/1, as of January 1, 1967. Chlorination facilities were to be added. The Baker Water and Sanitation District plant was one of the first to connect to the Metro system.

An in-plant evaluation was conducted August 11 through 16, 1971. Allen Jones, District Supervisor, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The principal components of this plant are as follows [Figure 1]:

1. Preliminary treatment -- bar screen, grit chamber, and comminutor.
2. Primary treatment -- two clarifiers (rectangular, each 47 ft x 23 ft x 10 ft).
3. Secondary treatment -- one high-rate trickling filter (65 ft in diameter, 7 ft depth), two rectangular clarifiers (same dimensions as primary units).
4. Disinfection -- chlorine contact chamber with detention time of 15 minutes at 1 mgd.
5. Digestion -- two-stage anaerobic digestion, sludge drying beds.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the influent and effluent (after chlorination) were collected using SERCO automatic samplers. Samples were composited on a flow weighted basis from measurements taken at the plant headworks. Periodic measurements were made for the pH, conductivity, and temperature. Grab samples were also collected periodically for bacteriological analyses and for chlorine residual measurements. [The analytical results are given in Table 1.]

The Baker plant discharged about 600 lb BOD and 350 lb of SS into Clear Creek. The BOD removal efficiency was slightly less than the 80 percent minimum required by the State.

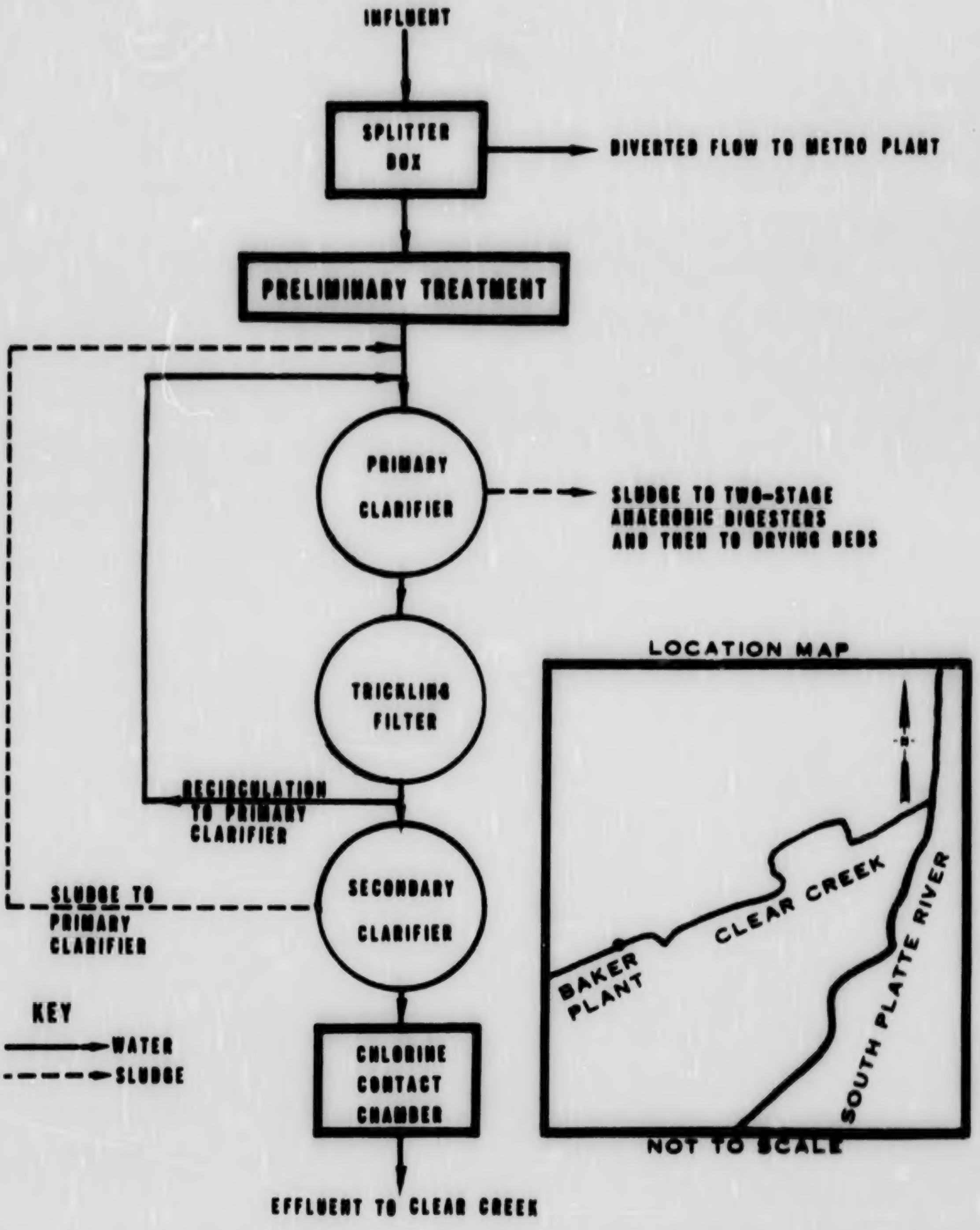
INFLUENT
SPLITTER BOX
DIVERTED FLOW TO METRO PLANT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS
TRICKLING FILTER
RECIRCULATION TO PRIMARY CLARIFIER
SECONDARY CLARIFIER
SLUDGE TO PRIMARY CLARIFIER
KEY
WATER
SLUDGE
CHLORINE CONTACT CHAMBER
EFFLUENT TO CLEAR CREEK
LOCATION MAP
N
CLEAR CREEK
SOUTH PLATTE RIVER
BAKER PLANT
NOT TO SCALE

Figure 1. Wastewater Treatment Plant, Baker Water and Sanitation District

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
BAKER WATER AND SANITATION DISTRICT
WASTEWATER TREATMENT PLANT
AUGUST 11-16, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			0.97-1.03	1.00	
pH (S.U.)	7.3-7.5		7.4-7.5		
Temperature (°C)	20-23		20-24		
Conductivity (µmhos/cm)	1,300-2,400		1,600-1,900		
BOD (mg/l)		330[b]		70[a]	79
Total Solids (mg/l)	1,300-2,700	1,800	1,100-1,200	1,170	
suspended solids (mg/l)	140-540	290	30-50	40	78-91
Settleable Solids (ml/l)	5-32	19	0.2-0.6	0.4	
TOC (mg/l)	270-330	298	137-150	144	47-59

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[a] Analyses for BOD, TOC, total solids, SS, and settleable solids were performed on composite samples.

[b] This is a single value.

Disinfection was adequate [Table 2]; however, it would appear from the high chlorine residuals observed that an excessive amount of chlorine was being applied.

D. SUMMARY AND CONCLUSIONS

Waste treatment practices have improved since the 1964 studies. The Baker plant can adequately treat 1.0 mgd of wastewater; however, it is feasible for the entire flow to be diverted to the Metro system and for operation of the Baker plant to be discontinued.

Chlorine, in excess of that required for adequate disinfection, was applied during the survey. This practice is considered wasteful and, at the chlorine residuals measured, could have a detrimental effect on the receiving waters.

E. RECOMMENDATIONS

It is recommended that the operation of the Baker plant be discontinued and all wasteflow be diverted to the Metro system.

F. REFERENCE

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin,* PR-3, U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965. Appendix B.

TABLE 2

BACTERIOLOGICAL RESULTS
BAKER WATER AND SANITATION DISTRICT
WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
August 11, 1971	0800	<100	<20	
	1200	65	<20	2.4
	1340	<100	<20	2.3
August 12, 1971	1050	8	<2	2.1
	1410	830	14	1.9
	1900	130	<2	1.8
August 13, 1971	0620	50	4	2.6
	1525	12	2	2.7

BOULDER WASTEWATER TREATMENT PLANTS
BOULDER, COLORADO

A. INTRODUCTION

The City of Boulder has two wastewater treatment plants, both located on Boulder Creek. The Pearl Street plant (RM 270.0/17.4/21.3) is a high-rate trickling filter system designed for an average flow of 4.3 mgd. This plant was constructed in 1957 at a cost of $1,100,000. The 75th Street plant (RM 270.0/17.4/17.8), constructed in 1968 at a cost of $1,819,000, is also a high-rate trickling filter facility designed for 5.2 mgd.

Both plants are operated continuously. The superintendent of sewer plant operations, Robert Hall, is responsible for both plants. The staff at the Pearl Street plant includes a supervisor, five operators, a mechanic, and a maintenance man. The 75th Street plant staff includes a supervisor, six operators, a mechanic, two maintenance men, and a laboratory technician who serves both plants. The operating budget in 1971 for these two plants was more than $300,000.

In 1967,[1/] the Pearl Street plant was seriously overloaded due to rapid population growth (population served was 56,000) and high rates of infiltration in older portions of the collection system with open sewer joints. Flows as high as 7.5 mgd were reported. Effluent from the plant was seriously degrading the waters of Boulder Creek. The 75th Street plant was under construction at that time to relieve the overloaded condition at the Pearl Street facility.

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Both plants were evaluated, August 17 through 20, 1971, by personnel of the National Field Investigations Center - Denver. Mr. Hall provided information and assistance during these evaluations.

B. WASTE TREATMENT FACILITIES

1. Pearl Street Plant - Relatively steady flow conditions are made possible because flow in excess of the plant capacity can be diverted to the 75th Street plant for treatment. Principal components of the Pearl Street plant [Figure 1] are:

a) preliminary treatment -- bar screen, grit chamber, and comminutor;

b) primary treatment -- one clarifier (110 ft in diameter, 7 ft deep);

c) secondary treatment -- one trickling filter (175 ft in diameter, 3.5 ft deep) and one clarifier (100 ft in diameter, 9 ft deep);

d) disinfection -- chlorine contact chamber with detention time of 15 minutes at a flow of 4.2 mgd; and

e) digestion -- two-stage anaerobic system (each digester 55 ft in diameter by 28 ft deep). (Sludge can be treated at this plant or transferred to the 75th Street plant.) Laboratory analyses are performed routinely at both plants for several parameters including BOD, suspended and settleable solids, volatile acids and pH.

2. 75th Street Plant - Principal components [Figure 2] of the 75th Street plant are as follows:

a) preliminary treatment - bar screen, grit chamber, and comminutor;

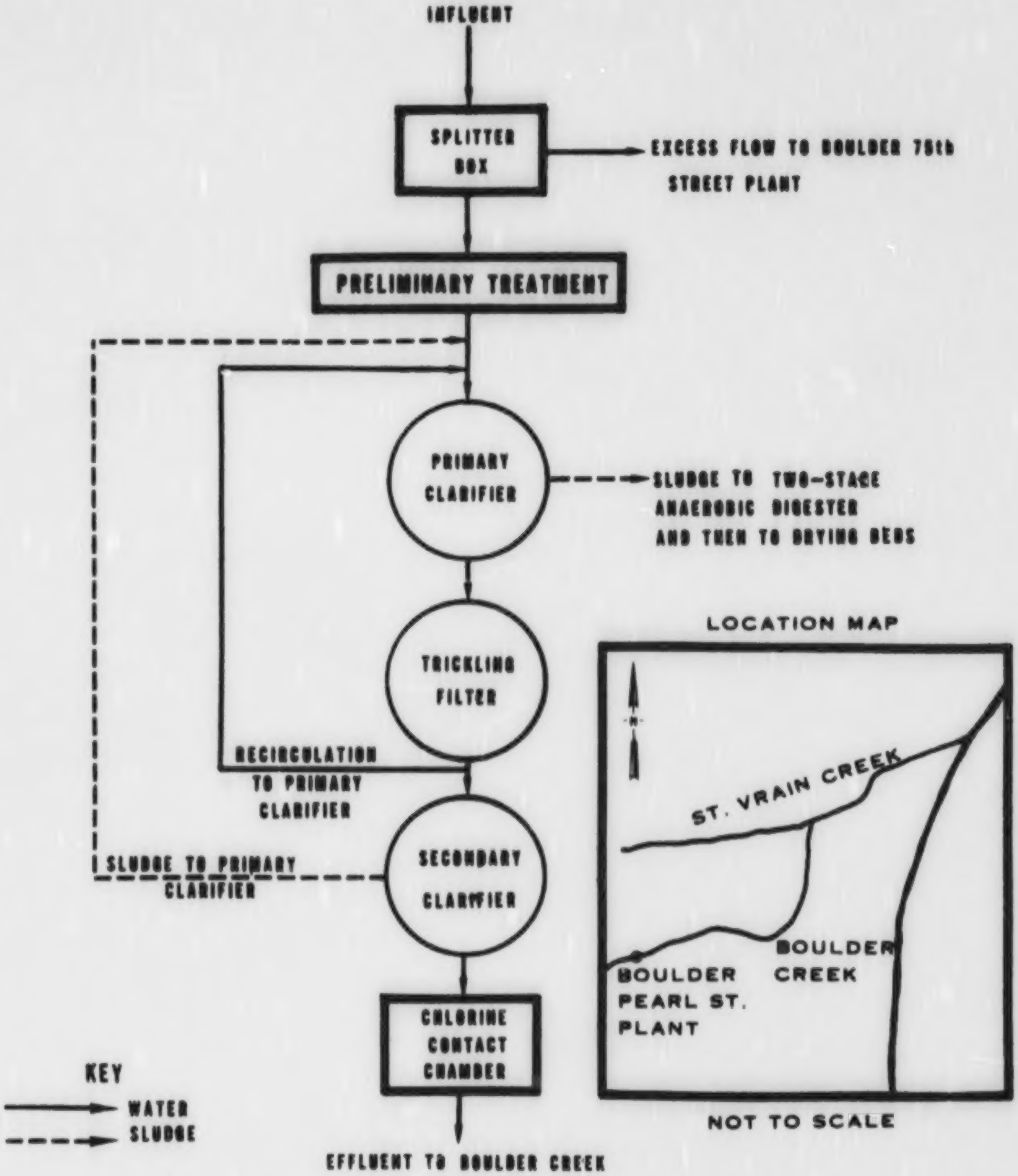
INFLUENT
SPLITTER BOX
EXCESS FLOW TO BOULDER 75th STREET PLANT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTER AND THEN TO DRYING BEDS
TRICKLING FILTER
RECIRCULATION TO PRIMARY CLARIFIER
SECONDARY CLARIFIER
SLUDGE TO PRIMARY CLARIFIER
CHLORINE CONTACT CHAMBER
EFFLUENT TO BOULDER CREEK
KEY
WATER
SLUDGE
LOCATION MAP
N
ST. VRAIN CREEK
BOULDER CREEK
BOULDER PEARL ST. PLANT
NOT TO SCALE

Figure 1. Wastewater Treatment Plant · East Pearl Street Boulder

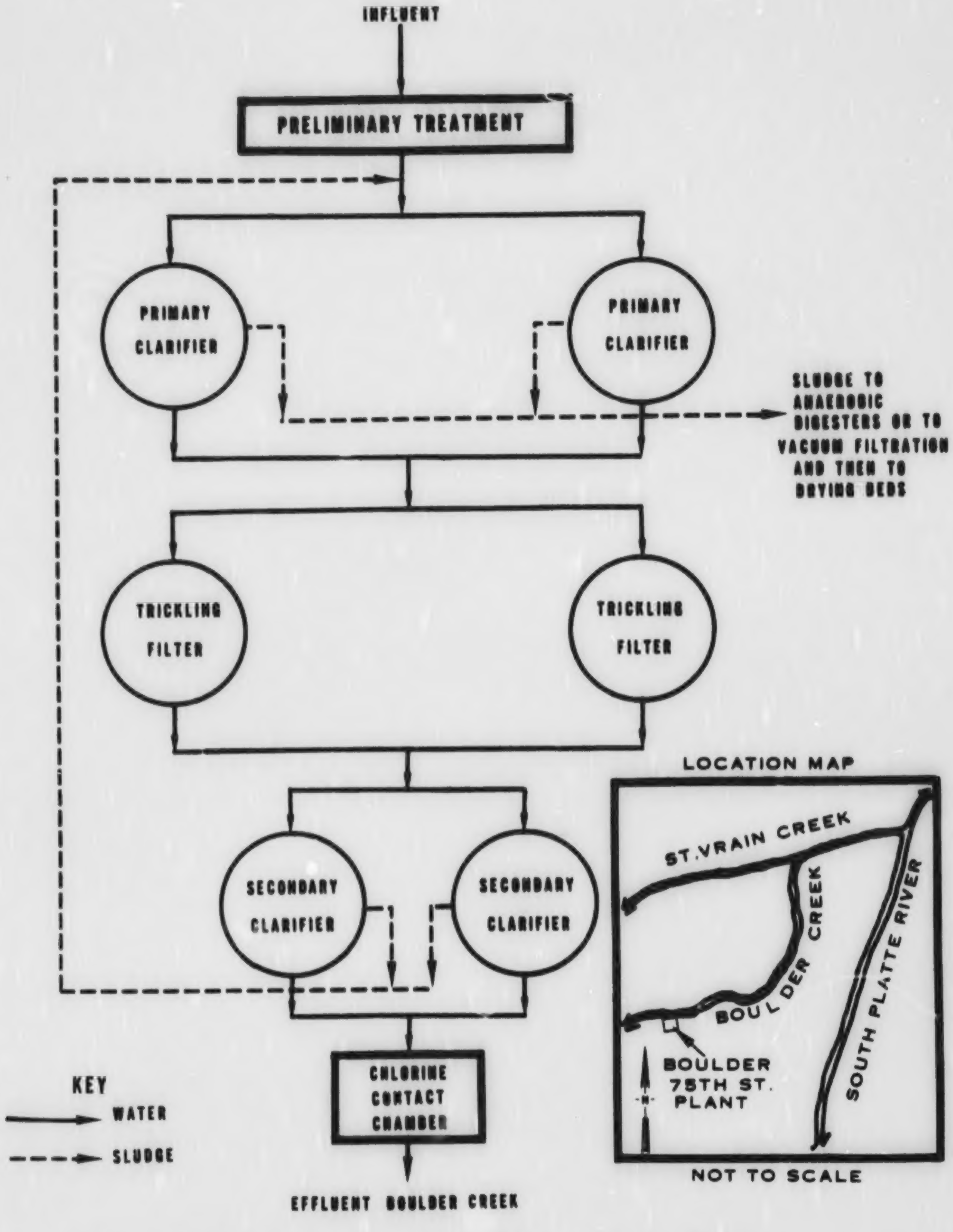
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
PRIMARY CLARIFIER
SLUDGE TO ANAEROBIC DIGESTERS OR TO VACUUM FILTRATION AND THEN TO DRYING BEDS
TRICKLING FILTER
TRICKLING FILTER
SECONDARY CLARIFIER
SECONDARY CLARIFIER
CHLORINE CONTACT CHAMBER
EFFLUENT BOULDER CREEK
KEY
WATER
SLUDGE
LOCATION MAP
ST. VRAIN CREEK
BOULDER CREEK
SOUTH PLATTE RIVER
BOULDER 75TH ST. PLANT
N
NOT TO SCALE

Figure 2. Wastewater Treatment Plant, 75th St. Boulder

b) primary treatment - two clarifiers (each 80 ft in diameter, 7 ft deep) operating in parallel;

c) secondary treatment - two trickling filters (each 155 ft in diameter, 8 ft deep) operated in parallel and two clarifiers (each 80 ft in diameter, 8 ft deep);

d) disinfection - chlorine contact chamber with detention time of 15 minutes at design capacity; and

e) digestion - two-stage anaerobic digester system, vacuum filters, and sludge beds.

An expansion program presently underway at this plant will increase the capacity to 15.6 mgd (completion date, October 1972). This expansion will provide a total wastewater treatment capacity (both plants) of 19.8 mgd. The additional facilities to be added are a primary clarifier (140 ft in diameter, 7 ft deep), two trickling filters (200 ft in diameter, 5 ft deep) in parallel, a secondary clarifier (140 ft in diameter, 7 ft deep), and an enlarged chlorine contact chamber which will provide 15 minutes detention time at a flow of 15.6 mgd.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hour composites of the influent and effluent (after chlorination) were collected at both plants from August 17 through 20, 1971. The composites were made up from grab samples collected manually each half hour from the influent and each hour from the effluent. The samples were composited on a flow weighted basis from measurements at the headworks. Temperature, pH, and conductivity were measured hourly at each sampling location. Grab samples were collected periodically for bacteriological analyses and chlorine residual measurements. [The results of the chemical and bacteriological analyses are contained in Tables 1 through 4.]

The BOD removal efficiency ranged from 45 to 77 percent at the Boulder Pearl Street plant. During the survey, the digesters were out of operation and sludge was being stored in the primary clarifier. Excessive solids were carried over from the primary clarifier, adversely affecting other plant operations. Repairs on the digesters were completed shortly after the survey. Solids were also observed in the chlorine contact chamber and in the final effluent. The sludge accumulations in the chamber were subsequently removed. This plant was providing adequate disinfection at the time of the survey.

The 75th Street plant [Table 2] removed 60 to 90 percent (average 77 percent) of the BOD. Flows exceeded the design capacity by 50 percent. An expansion program is currently underway to double the hydraulic capacity of the plant. The bacteriological analyses showed disinfection was adequate during the survey except on one occasion when the chlorinator was out of operation [Table 4].

A stream survey in September 1971[2/] showed that the discharge from the two Boulder treatment plants degraded water quality and the stream bed environment of Boulder Creek. Violations of Sections B and D of the Colorado Basic Standards Applicable to All Waters of the State occurred. However, conditions were less severe during the September 1971 stream survey than those reported in 1967.[3/]

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
BOULDER PEARL STREET WASTEWATER TREATMENT FACILITY
AUGUST 17-19, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			3.55-4.29	4.00	
pH (S. U.)	6.5-7.7		6.7-7.5		
Temperature (°C)	18.5-23.5		19.5-23.5		
Conductivity (µmhos/cm)	400-630		125-510		
BOD (mg/1)	130-170	140	30-75	48	42-77
COD (mg/1)	240-1,160	700	115-185	150	23-90
TOC (mg/1)	114-123	117	24-43	34	62-80
Total Solids (mg/1)	750-1,060	925	220-370	355	
Suspended Solids (mg/1)	120-150	130	18-50	36	66-83
Settleable Solids (ml/1)	5[b]		Trace[b]		

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[a] Analyses for BOD, COD, TOC, Total Suspended and Settleable Solids were performed on composite samples.

[b] This is a single value.

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
BOULDER 75TH STREET WASTEWATER TREATMENT FACILITY
AUGUST 17-20, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			7.73-8.03	7.84	
pH (S. U.)	6.5-8.0		6.3-7.6		
Temperature (°C)	18-22		16-21.5		
Conductivity (µmhos/cm)	410-800		525-1,000		
BOD (mg/1)	160-190	173	16-75	41	60-90
TOC (mg/1)	84-123	105	21-29	25	75-78
COD (mg/1)	260-520	373	110-230	153	54-67
Total Solids (mg/1)	400-560	497	370-490	433	
Suspended Solids (mg/1)	110-130	120	15-35	28	64-83
Settleable Solids (ml/1)	0.35[b]		Trace[a]		

---

[a] Analyses for BOD, TOC, COD, Total, Suspended, and Settleable Solids were performed on composite samples.

[b] This is a single value.

TABLE 3

BACTERIOLOGICAL RESULTS
BOULDER PEARL STREET WASTEWATER TREATMENT PLANT

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/l
August 17, 1971	0800	1,300	20	1.5
	1030	220	22	1.2
	1300	320	22	1.4
August 18, 1971	0930	200	6	1.5
	1430	180	31	1.2
	1930	420	62	1.5
August 19, 1971	0700	340	19	2.1
	1530	120	2	1.3

TABLE 4

BACTERIOLOGICAL RESULTS
BOULDER 75TH STREET WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/l
August 17, 1971	0935	3,400	32	2.5
	1035	820	20	1.9
	1300	450	<2	2.0
August 18, 1971	0800	>80,000	>6,000	0.0
	1430	170	7	1.6
	1925	28,000	560	1.6
August 19, 1971	0700	250	19	
	1530	4,000	12	0.7

Low-flow conditions for Boulder Creek for a 20-year period, 1951-70, were examined at a U.S.G.S. gaging station (RM 28.9); the seven-day, ten-year low flow is 3.3 cfs.* Tributary inflows (e.g. South Boulder Creek) and accretions (during the non-irrigation season) increase the flow between the gaging station and the points of discharge from the Boulder treatment plants. If it is assumed that flow downstream from South Boulder Creek is 25 cfs (not including the Pearl Street discharge) then, in order to maintain a DO level of 5.0 mg/1, the plant discharges can contain no more than 20 mg/1 BOD.

D. SUMMARY AND CONCLUSIONS

1. The BOD removal efficiencies at the two Boulder plants did not meet the Colorado requirements for secondary treatment because of operational difficulties at the Pearl Street plant and hydraulic overloading at the 75th Street plant. Moreover, additional treatment is required at the two plants if the stream standards are to be met.

2. Adequate disinfection was generally provided at both plants during the survey.

3. Infiltration in the older portions of the collection system contribute to the hydraulic overloading of the 75th Street plant.

4. The planned expansion at the 75th Street plant should alleviate the hydraulic-overload conditions observed during the survey.

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* Low-flow conditions for the period of record occurred during the non-irrigation season, October to May.

E. RECOMMENDATIONS

It is recommended that:

1. The biochemical oxygen demand and the suspended solids in the effluents from the Boulder plants not exceed 20 mg/l or 3,300 lb/day of each (700 lb/day from the Pearl Street plant and 2,600 lb/day, 75th Street plant), whichever is less.

2. The infiltration into the collection system be reduced.

F. REFERENCES

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-1967*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967 (unpublished report).

2/ *Water Quality Investigations in the South Platte River Basin, Colorado, 1971-1972*, U. S. Environmental Protection Agency, National Field Investigations Center - Denver and Region VIII, Denver, Colorado, April 1972.

3/ *Effects of Pollution on Aquatic Life Resources of the South Platte River Basin in Colorado*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, Denver, Colorado and Technical Advisory and Investigation Branch, Cincinnati, Ohio, Report PR-11, December 1967.

BRIGHTON WASTEWATER TREATMENT PLANT
BRIGHTON, COLORADO

A. INTRODUCTION

The Brighton wastewater treatment plant, a standard-rate trickling filter plant, serves approximately 10,000 people. The plant is manned eight hrs/day by one operator. The effluent is discharged to the South Platte River (RM 295.8).

An in-plant survey conducted in 1964[1/] indicated that the Brighton wastewater treatment facility was providing 95 percent BOD and 84 percent suspended solids removal. The average flow of 0.65 mgd was below plant design and chlorination facilities were providing adequate disinfection of the effluent.

The in-plant evaluation was conducted from September 27 through 29, 1971. C. B. Dornbusch, Director of Public Works, and Edward Finley, Plant operator, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The plant is designed for a capacity of 1.8 mgd. The principal components [Figure 1] of this system are:

1. Preliminary treatment -- grit chamber, bar screen and comminutor;
2. Primary treatment -- clarifier (65 ft in diameter, 12 ft deep);
3. Secondary treatment -- trickling filter (80 ft in diameter and 6 ft deep) and clarifier (55 ft in diameter, 9 ft deep);
4. Chlorine contact chamber (58 ft by 9 ft by 5 1/2 ft) with average detention time of 23 minutes at present flows; and
5. Two-stage anaerobic digestion system.

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The plant is presently under expansion, with financial assistance from an EPA grant. The expansion will cost $861,000 and is scheduled for completion January 1973. Included in the expansion are: a) addition of a headworks building with automatic bar screens and grit chambers; b) modification of existing primary clarifier to provide automatic sludge removal; c) two additional trickling filters (each 90 ft in diameter and 6 ft deep); d) a second chlorine contact chamber; e) replacement of piping in clarifiers and arms on existing trickling filter; and f) cleaning and repair of existing digesters.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the influent and effluent (after chlorination) were collected using SERCO automatic samplers and composited on a flow weighted basis from readings obtained at the headworks. Temperature, pH, and conductivity were measured periodically. Grab samples of the effluent (after chlorination) were collected for bacteriological analyses and measured for chlorine residual.

During the survey the following visual observations were made.

1. Groundwater from excavation for the new headworks building was pumped into the primary clarifier, thus reducing the clarifier's effectiveness.

2. The existing scum receptacle must be cleaned manually. As operators are on duty only 16 hr/day, the receptacle filled at night and allowed floating material to pass over the weirs and flow to the trickling filter. This will be corrected after completion of the present expansion program.

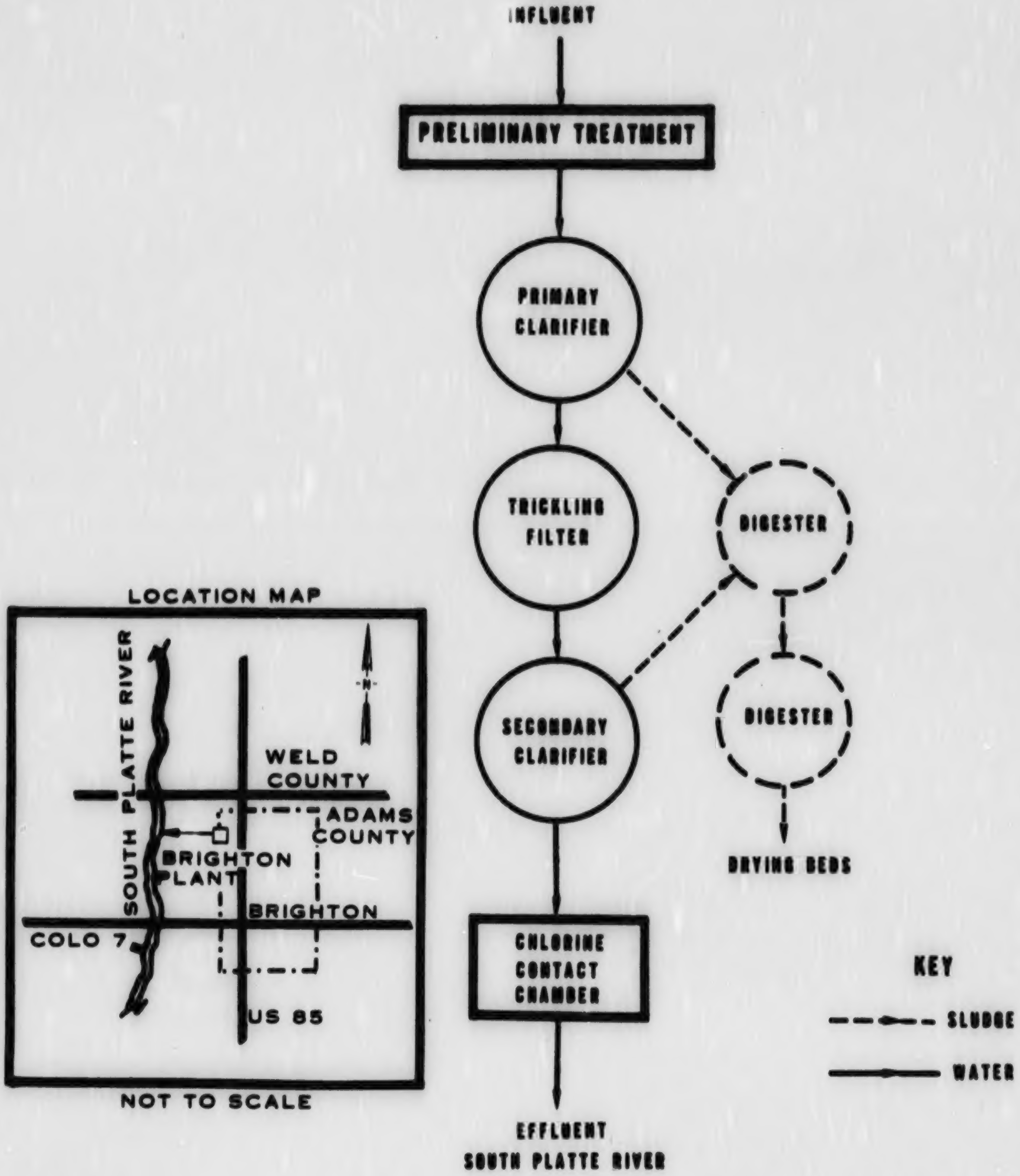
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
TRICKLING FILTER
DIGESTER
SECONDARY CLARIFIER
DIGESTER
DRYING BEDS
CHLORINE CONTACT CHAMBER
EFFLUENT
SOUTH PLATTE RIVER
KEY
SLUDGE
WATER
LOCATION MAP
N
SOUTH PLATTE RIVER
WELD COUNTY
ADAMS COUNTY
BRIGHTON PLANT
BRIGHTON
COLO 7
US 85
NOT TO SCALE

Figure 1. Wastewater Treatment Plant , Brighton

3. The rock medium in the existing trickling filter was too small, allowing ponding to occur.

4. Laboratory facilities have been provided at the plant for the performance of chemical tests of sewage quality. The numbers and types of chemical tests performed were limited to only basic analyses (e.g. pH, chlorine residual, and temperature). Records of plant operation reflect flows and normal maintenance procedures. The operator should be trained to perform necessary tests to provide efficient operation of the plant.

The data collected during the 1971 survey [Table 1] show that the efficiency of BOD removal ranged from 50 to 74 percent, less than the 80 percent minimum level required by the State of Colorado. There was no detectable chlorine residual in the effluent throughout the survey. The plant maintains a chlorine dosage rate of 20 to 25 lb/day, the equivalent of approximately 2 mg/l, which is less than the Colorado State recommendations of 15 mg/l in a trickling filter effluent.2/ The State also requires a chlorine residual level of 1 mg/l after 15 minutes detention time at peak hourly flow. The inadequacy of disinfection is reflected in the high fecal coliform bacterial densities detected in the effluent [Table 2] ranging from 340,000 to 1,900,000/100 ml during the survey.

D. CONCLUSIONS

1. The plant performance did not conform to the minimum requirement of 80 percent BOD removal, as established by the State of Colorado, and the effluent is inadequately disinfected.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
BRIGHTON WASTEWATER TREATMENT FACILITY
September 28-30, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Avg	Range	Avg	
Flow (mgd)			1.2-1.4	1.3	
pH (S.U.)	7.3-7.7		7.1-8.1		
Temperature (°C)	15-20		16-20		
Conductivity (μmhos/cm)	1400-3250		2000-3000		
BOD (mg/l)	100-230	156	50-60	53	50-74
Total Solids (mg/l)	1810-1960	1880	1500-1590	1550	17-19
Suspended Solids (mg/l)	160-200	175	60-100	80	50-65
C (mg/l)	100-290	160	50-70	55	50-75
Total N (mg/l)	21-22	22	16-19	18	
NH_3 (mg/l)	13-15	14	12-13	12	
$NO_2 + NO_3$ (mg/l)	0.06-0.92	0.45	0.11-0.37	0.23	
Total P (mg/l)	8-11	10	8.6-9.6	9.1	

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[a] Analyses for BOD, total solids, suspended solids, TOC, total N, NH_3, $NO_2 + NO_3$, and total P were performed on composite samples.

TABLE 2

BACTERIOLOGICAL RESULTS FOR BRIGHTON WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Cl_2 Residual mg/1
9/27/71	1510	> 800,000	1,000,000	0.0
9/28/71	0740	> 800,000	860,000	0.0
	1710	8,900,000	340,000	0.0
9/29/71	1110	8,800,000	1,900,000	0.0

2. The Brighton wastewater treatment plant is currently being expanded. The expanded facilities are scheduled to be in operation in January 1973.

3. Laboratory facilities have been provided but are not used to provide the most efficient operation of the plant.

E. RECOMMENDATIONS

It is recommended that:

1. Until the new treatment facility is placed in operation, the chlorine dosage rate be increased to insure adequate disinfection of the effluent.

2. The operator receive formal training in the operation of this plant by schooling and by on-the-job training.

3. The biochemical oxidation demand and suspended solids in the Brighton Treatment Plant effluent not exceed 30 mg/l or 440 lb/day of each at design flow, whichever is less.

F. REFERENCES

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin*, PR-3, U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965. Appendix B.

2/ *Criteria Used in the Review of Waste Water Treatment Facilities*, Colorado Department of Health, Denver, Colorado, September 1969.

BRUSH WASTEWATER TREATMENT PLANT
BRUSH, COLORADO

A. INTRODUCTION

The Brush wastewater treatment plant serves a population of approximately 3,500 and treats wastewater (approximately 0.5 mgd) from the Sigman Meat Company. The present plant was constructed in 1966 as a replacement for one that was destroyed in the 1965 flood of the South Platte River. The plant is manned eight hrs/day, five days/week by one operator. The effluent is discharged by the municipal plant to the Platte River at RM 185.6.

In 1967[1/] this plant was treating 0.55 mgd (0.34 mgd contributed by Sigman Meat Company). The chlorination facilities were not in operation at that time.

The in-plant survey was conducted from January 25 through 29, 1972. John West, City Manager, and Jesse Law, plant supervisor, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The plant is designed for a capacity of 0.9 mgd. The principal components are [Figure 1]:

1. Preliminary treatment -- manual bar screen, grit chamber, and comminutor;
2. Primary treatment -- clarifier, (50 ft in diameter and 10 ft deep) -- at 1.1 mgd the surface overflow rate was 560 gpd/ft with a detention time of 3.2 hr;
3. Secondary treatment -- two high-rate trickling filters operated

in series (each 100 ft in diameter and 7 ft deep), with small rock (2 1/2 in.) being used as the trickling filter media and a clarifier (50 ft in diameter and 10 ft deep) -- at 1.1 mgd the surface overflow rate was 560 gpd/ft^2 with a detention time of 3.2 hr;

4. Disinfection -- chlorine is added to the effluent from the final clarifier with a 1,200 ft outfall line to the river providing the detention time; and
5. Digestion -- one heated digester (55 ft in diameter and 24 ft deep) with the supernatant and digested sludge used for fertilizer on non-edible crops.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the effluent from the Sigman Meat Company, the combined influent to the treatment plant, and the effluent from the plant (after chlorination) were collected using SERCO automatic samplers on January 26, 28 and 29, 1972. Samples were composited on a flow weighted basis from readings obtained at the headworks. Temperature, pH, and conductivity, of the treatment plant influent and effluent were measured periodically. Grab samples of the effluent were collected for bacteriological analyses.

During the survey, it was noted that:

1. The arms of the first trickling filter were not rotating freely because of the buildup of grease, from the packing company, on the bearings.

2. The weirs on the primary clarifier were not level, which caused uneven flow distribution; and

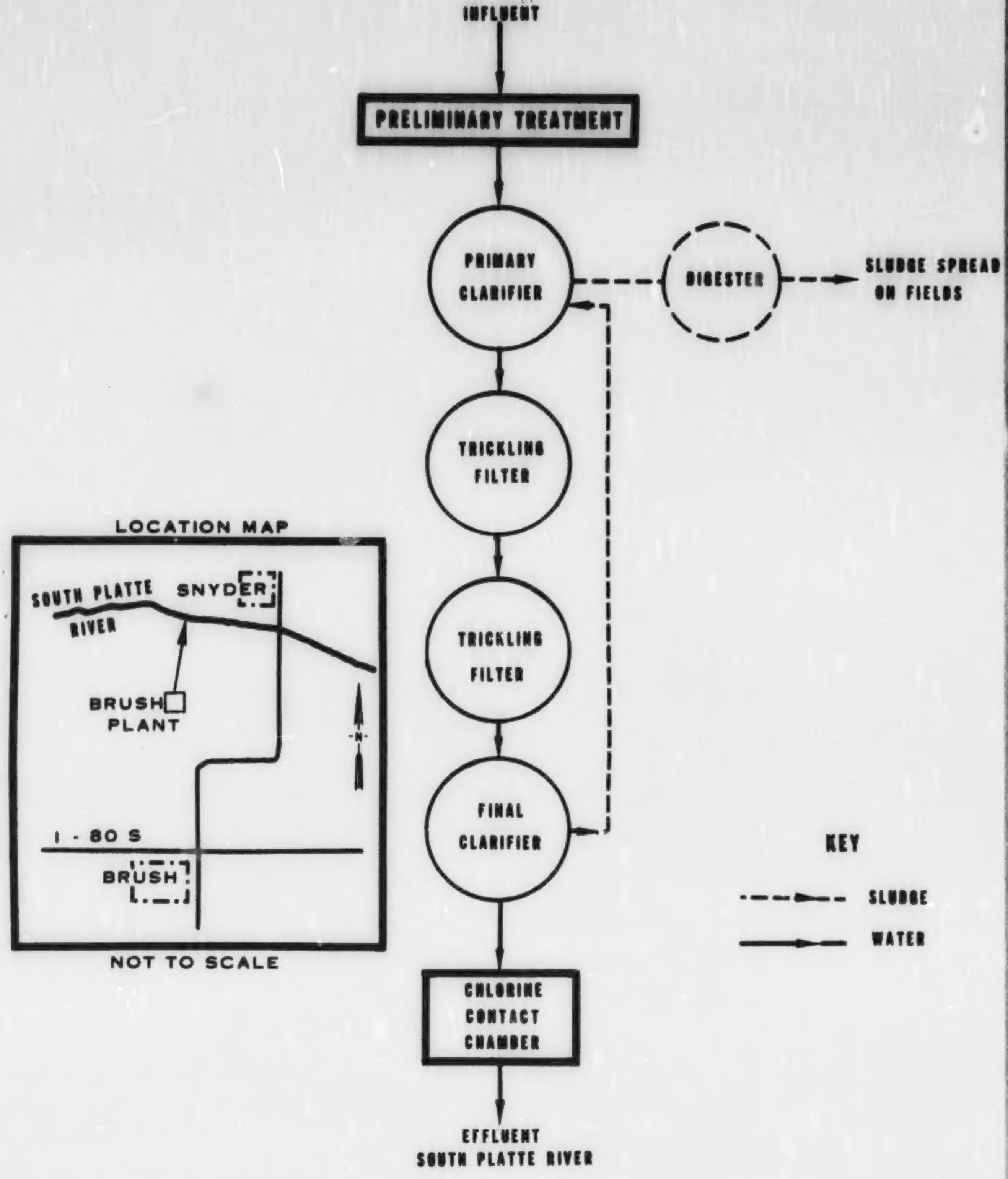
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
DIGESTER
SLUDGE SPREAD ON FIELDS
TRICKLING FILTER
TRICKLING FILTER
FINAL CLARIFIER
CHLORINE CONTACT CHAMBER
EFFLUENT SOUTH PLATTE RIVER
KEY
SLUDGE
WATER
LOCATION MAP
SOUTH PLATTE RIVER
SNYDER
BRUSH PLANT
N
I - 80 S
BRUSH
NOT TO SCALE

Figure 1. Wastewater Treatment Plant , Brush

3. The chlorination equipment was not in operation because of equipment malfunction. Plant officals indicated a new chlorinator is on order.

4. Routine maintenance of plant facilities was being provided.

5. Laboratory analysis are performed on the quality of the sewage and on Sigman Meat Company effluent. BOD tests are run daily on both the Sigman effluent and the treatment plant effluent. In addition suspended and settleable solids measurements are made of the plant effluent.

The Sigman Meat Company processes about 2,400 hogs per day, five days a week. Wastewaters receive primary treatment to remove grease and solids prior to discharge into the Brush municipal sewers. During the 1972 survey the BOD and suspended solids in the meat company wastes ranged from 1,030-1,200 mg/1 and 664-1,780 mg/1, respectively [Table 1]. Waste loads from Sigman constitute more than 70 percent of the BOD load and more than 50 percent of the suspended solids load to the Brush treatment plant.

Removal efficiencies of BOD and SS, at the Brush plant, ranged from 83-85 and 94-98 percent, respectively [Table 2]. Although the BOD removal efficiency was greater than the 80 percent minimum removal required by the State of Colorado, the effluent BOD (average level of 140 mg/1) is considered excessive. The high influent BOD (610-1,320 mg/1) is a result of the waste loads from the Sigman Meat Company. To be consistent with waste discharge limits established for industry under the Refuse Act Permit Program, the effluent from the Brush plant should contain no greater than 30 mg/1 of BOD and SS. In order to accomplish this objective, pretreatment of the Sigman wastes is necessary so as to reduce BOD levels to those comparable with domestic sewage (250 mg/1).

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
SIGMAN MEAT PACKING PLANT, BRUSH, COLORADO
JANUARY 26-28, 1972

Parameter[a]	Effluent	
	Range	Average
Flow (mgd)	0.5-0.7	0.6
pH (S.U.)	6.3-6.8	
Temperature (°C)	9-13	
Conductivity (µmhos/cm)	1,100[b]	
BOD (mg/l)	1,030-1,200	1,140
COD (mg/l)	2,130-4,550	3,070
Total Solids (mg/l)	1,720-3,220	2,280
Suspended Solids (mg/l)	664-1,780	1,080

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[a] Analyses for BOD, COD, total solids, and suspended solids were performed on composite samples.

[b] This is a single value.

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
BRUSH WASTEWATER TREATMENT FACILITYJANUARY 26, 28, and 29, 1972

Parameter[a/]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			1.07-1.21	1.11	
pH (S.U.)	6.6-7.3		7.5-7.9		
Temperature (°C)	14-19		4.0-11.5		
Conductivity (umhos/cm)	850-1,100		900-1,250		
BOD (mg/1)	610-1.320	860	100-220	140	83-85
COD (mg/1)	1,620-2,180	1,810	143-450	337	74-91
Total Solids (mg/1)	1,200-3,320	2,256	698-920	773	41-79
Suspended Solids (mg/1)	535-1,580	1,118	29-74	45	94-98

[a/] Analyses for BOD, COD, total solids, and suspended solids were performed on composite samples.

Disinfection was not provided as reflected by bacteriological analysis [Table 3]; this is in violation of Colorado standards.

D. SUMMARY AND CONCLUSIONS

1. Although the BOD removal efficiency at the Brush plant ranged from 83-85 percent, the effluent BOD level was still excessive. Violations of the Colorado Water Quality Standards occurred for inadequate disinfection of municipal waste effluents.

2. The waste loads discharged from the Sigman Meat Company constituted more than 70 percent of the BOD and more than 50 percent of the suspended solids loads to the Brush plant. Grease from the meat company caused operational problems in the trickling filters by building up on the bearings and preventing free rotation of the filter arms.

3. Operation of the plant is not adequate. Operator training is required.

E. RECOMMENDATIONS

It is recommended that:

1. The Sigman Meat Company pretreat wastes to the degree such that the effluent contain levels of biochemical oxygen demand and suspended solids equivalent to that in domestic wastes (250 mg/l).

2. The effluent from the Brush plant contain no more than 30 mg/l or 300 pounds each of biochemical oxygen demand and suspended solids, whichever is less.

3. Disinfection be provided in accordance with state regulations and the plant effluent contain no more than 1000 fecal coliform bacteria/100 ml.

TABLE 3

BACTERIOLOGICAL RESULTS
BRUSH WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml
January 26, 1972	1045	>8,000,000	11,000,000
	1145	>8,000,000	9,000,000
January 27, 1972	1000	16,000,000	6,200,000
	1100	28,000,000	6,700,000
January 28, 1972	1035	8,200,000	5,100,000
	1200	960,000	140,000

4. The weirs in the primary clarifier be leveled to prevent uneven flow distribution.

5. The plant operator be provided training in the operation of the plant by attendance at an operator school and be given on-the-job training.

F. REFERENCE

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67,* U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

CLEAR CREEK VALLEY SANITATION DISTRICT
WASTEWATER TREATMENT PLANT
ARVADA, COLORADO

A. INTRODUCTION

The Clear Creek Valley Sanitation District plant (RM 311.1/7.0) treats the domestic wastes from approximately 13,000 people (which includes the Ridge Home for Retarded Children), and industrial wastes from Sigman Meat Company and Containers Incorporated. The plant is staffed by four operators who man the plant sixteen hours/day, seven days/week. The primary facilities were constructed in 1952; a trickling filter and secondary clarifier were added in 1960, followed by "Rapid Floc" aeration in 1967. At that time the old clarifier was converted to a chlorine contact chamber and new secondary clarifier units were installed.

In 1964,[1/] this plant was providing inadequate treatment. It was hydraulically and organically overloaded (plant capacity of 0.85 mgd with influent BOD of 865 mg/l as a result of the Sigman Meat Company wastes). Chlorination facilities were available but not in use. There were no laboratory facilities and no plant operation records were maintained. The District originally considered connecting to the Metropolitan Denver Sewage Disposal District No. 1 plant (Metro), but subsequently decided to build additional treatment facilities instead.

Personnel from the National Field Investigations Center-Denver conducted an in-plant evaluation from August 11-14, 1971. Orval Smith, District Superintendent, provided assistance and information on the Clear Creek system.

B. WASTE TREATMENT FACILITIES

The design capacity of this plant is 2.1 mgd. Treatment facilities [Figure 1] include:

1. Preliminary treatment -- bar screen, grit chamber, and comminutor.
2. Primary treatment -- one clarifier (30 ft by 90 ft by 8 ft-Link Belt).
3. Secondary treatment -- one high-rate trickling filter (90 ft in diameter, 7 ft deep), aeration units, two rectangular tanks of 2 mgd each (34 ft by 93 ft by 9 ft deep), clarifier (93 ft by 37 ft by 16 1/2 ft deep).
4. Disinfection -- chlorine contact chamber is an old secondary clarifier (40 ft in diameter, 7 ft deep).
5. Digestion -- two-stage anaerobic system (primary digester--37 ft in diameter, 25 ft high; secondary digester, 25 ft in diameter by 25 ft high); digested sludge is placed in drying beds.

Flow is metered by a Parshall flume and continuously recorded and totalized.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites* of the plant influent and effluent (after chlorination) and the wastewater from Sigman were collected from August 11 through 14, 1971. Temperature, pH, and conductivity measurements were made every two hours and grab samples of the effluent were collected periodically for bacteriological analyses and measurement of chlorine residual.

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* Grab samples were collected manually every hour and composited on a flow weighted basis from flow measurements at the headworks.

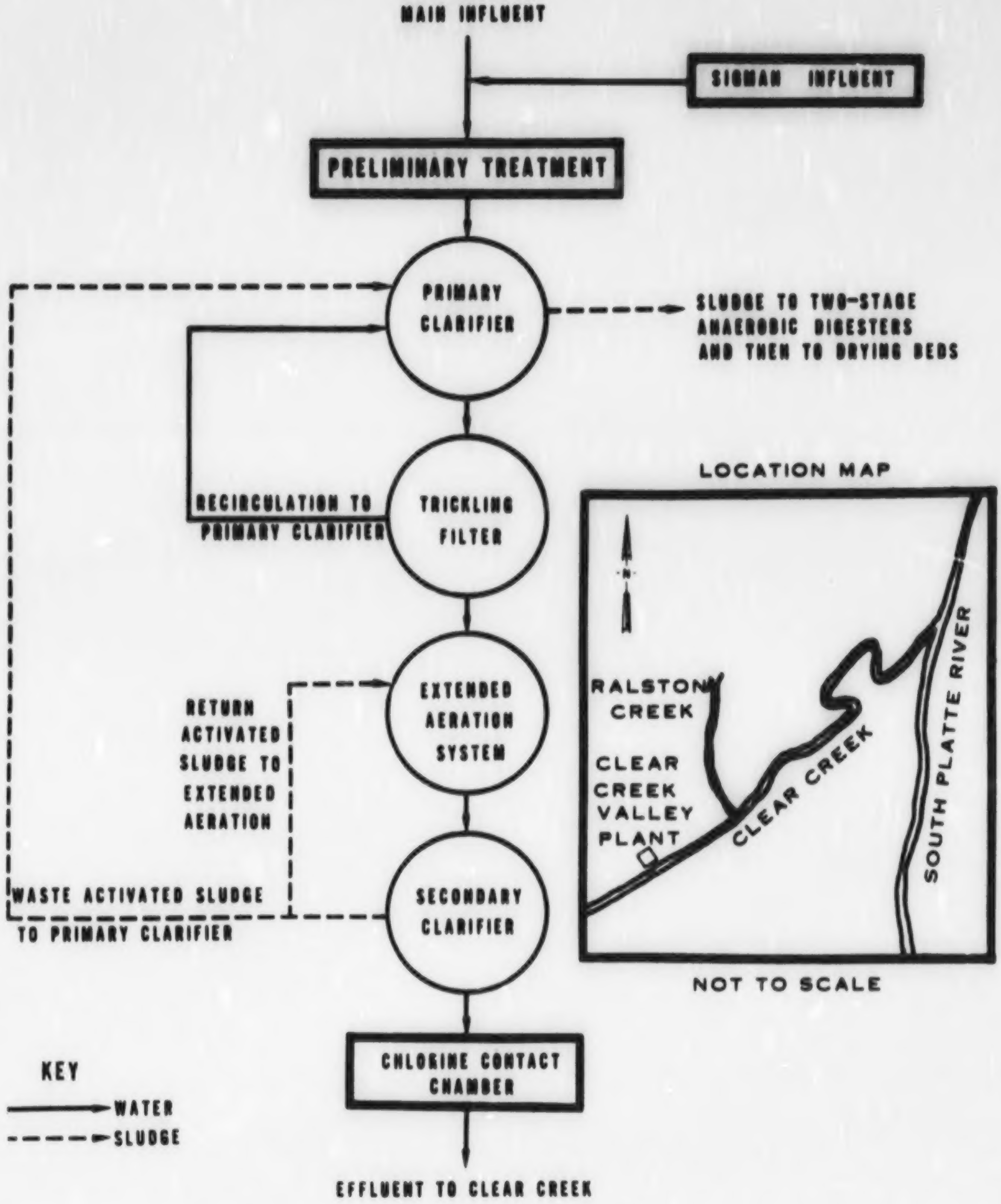
MAIN INFLUENT
SIGMAN INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS
RECIRCULATION TO PRIMARY CLARIFIER
TRICKLING FILTER
RETURN ACTIVATED SLUDGE TO EXTENDED AERATION
EXTENDED AERATION SYSTEM
WASTE ACTIVATED SLUDGE TO PRIMARY CLARIFIER
SECONDARY CLARIFIER
CHLORINE CONTACT CHAMBER
EFFLUENT TO CLEAR CREEK
KEY
WATER
SLUDGE
LOCATION MAP
N
RALSTON CREEK
CLEAR CREEK VALLEY PLANT
CLEAR CREEK
SOUTH PLATTE RIVER
NOT TO SCALE

Figure 1. Wastewater Treatment Plant - Clear Creek Valley Sanitation District

The Sigman Meat Company contributed about 3,600 lb of BOD (1,200 mg/l) and 1,750 lb of SS (587 mg/l) to the Clear Creek plant during the survey. This waste load has not significantly changed since the 1964 survey. Total influent waste loads averaged approximately 6,000 lb BOD and 3,000 lb SS. Survey data [Table 1] show that the Clear Creek plant was providing 93-95 percent removal of BOD. Flows averaged 2.5 mgd during the survey -- exceeding design capacity about 20 percent. Instantaneous flow readings ranged from 1.75 to 3.1 mgd. During daylight hours the flow generally ranged from 2.0 to 3.1 mgd. It was during these periods that solids were observed carried over from the final clarifier into the chlorine contact chamber. Moreover, the weirs of the final clarifier were submerged during peak flows.

Chlorine residuals ranged from 0.5-1.4 mg/l and, except for the first day of the survey, disinfection was effective as evidenced by fecal coliform bacteria densities [Table 2].

This plant is located in proximity to the Clear Creek interceptor of the Metro system. Connection to this interceptor is a reasonable alternative to plant expansion.

D. SUMMARY AND CONCLUSIONS

Treatment has improved markedly since the 1964 project studies. Overall plant operation and maintenance, including the staffing and routine laboratory analyses, are adequate. However, population growth in the service area and increased flows during the summer months have caused hydraulic overloading of the plant and subsequent solids carry-over.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
CLEAR CREEK VALLEY WASTEWATER TREATMENT FACILITY
AUGUST 11-14, 1971

Parameter[a]	Influent		Effluent		
	Range	Average	Range	Average	Percent Removal
Flow (mgd)			2.45-2.57	2.50	
pH (S.U.)	6.8-9.0		7.1-7.6		
Temperature (°C)	20-23		21-23		
Conductivity (µmhos/cm)	700-2,400		1,200-1,500		
BOD (mg/1)	220-350	285	15-19	17	93-95
TOC (mg/1)	72-102	96	19-29	22	69-81
Suspended Solids (mg/1)	100-170	143	20-70	36	59-87
Settleable Solids (ml/1)	2[b]	2	Trace-2.5	1.5	

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[a] Analyses for BOD, TOC, suspended solids, and settleable solids were performed on composite samples.

[b] All values are equal.

TABLE 2

BACTERIOLOGICAL RESULTS
CLEAR CREEK VALLEY WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
August 11, 1971	0930	24,000	520	0.6
	1120	290,000	32,000	0.5
	1300	6,600,000	57,000	0.5
August 12, 1971	1015	310,000	420	0.6
	1340	62,000	33	0.6
August 13, 1971	0650	1,100	6	1.4
	1450	21,000	68	0.8

The district could connect to the Clear Creek interceptor and divert all flow into the Metro system, precluding the need for further plant expansion.

E. RECOMMENDATIONS

It is recommended that:

1. The Clear Creek Valley Sanitation District discontinue operation of the existing plant by connection to Metro when the latter facility has adequate capacity to treat these waste loads.

2. The Sigman Meat Company pretreat wastes to the degree such that the effluent contain levels of biochemical oxygen demand and suspended solids comparable to that in domestic wastes (250 mg/1).

F. REFERENCE

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin,* U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965, Appendix B.

ENGLEWOOD WASTEWATER TREATMENT PLANT
ENGLEWOOD, COLORADO

A. INTRODUCTION

The Englewood wastewater treatment plant is located on the South Platte River (RM 325.1) and serves a population of approximately 63,000 persons. Except for chlorination, the high-rate trickling filter plant is divided into two separate sections: the first section was constructed in 1954; the second, in 1961. Chlorination was added in 1966. The plant is manned continuously.

A study, conducted in 1964,[1/] revealed that the plant was serving a population of approximately 55,000. The BOD removal efficiency was 82 percent with approximately 715 lb of BOD/day being discharged to the South Platte River.

A survey, conducted by the National Field Investigations Center-Denver (EPA) from September 20 through 25, 1971, determined only waste loads discharged into the South Platte River. Englewood Director of Public Works, Charles Carroll, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The design capacity of the Englewood plant is 8 mgd. The two sections of the plant are identical in configuration and size and have the following principal components [Figure 1]:

1. Preliminary treatment -- grit chamber, bar screen, and comminutor;
2. Primary treatment -- one clarifier;
3. Secondary treatment -- two high-rate trickling filters in parallel and a clarifier;

4. Digestion -- primary and secondary digester; and
5. Disinfection -- the effluent leaving each secondary clarifier flows to a common chlorine contact chamber.

Laboratory analyses are routinely performed in order to determine the quality of the wastewater. Analyses include: BOD, settleable solids, suspended solids, total solids, chlorine residual, volatile acids, pH, and alkalinity. In addition to these data, plant operating records also include measured values of daily flow, gas production, and grit removal.

At the time of the 1971 survey the plant was being expanded to a capacity of 12 mgd by the addition of a contact stabilization unit. Major repairs were in progress on the lift stations, headworks, trickling filters, and digesters. Sludge lines were being replaced. The City of Englewood received permission from the Colorado Water Pollution Control Commission to divert the total flow through one section of the plant while the repairs and modifications were being made.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the effluent (before chlorination) were collected, using SERCO automatic samplers; the samples were composited on a flow weighted basis from measurements obtained at the headworks. Composite samples of the effluent (after chlorination) were collected by plant personnel. Temperature, pH, and conductivity were measured periodically. Grab samples of the effluent were collected for bacteriological analyses and measured for chlorine residual. [Chemical and bacteriological data are summarized in Tables 1 and 2.]

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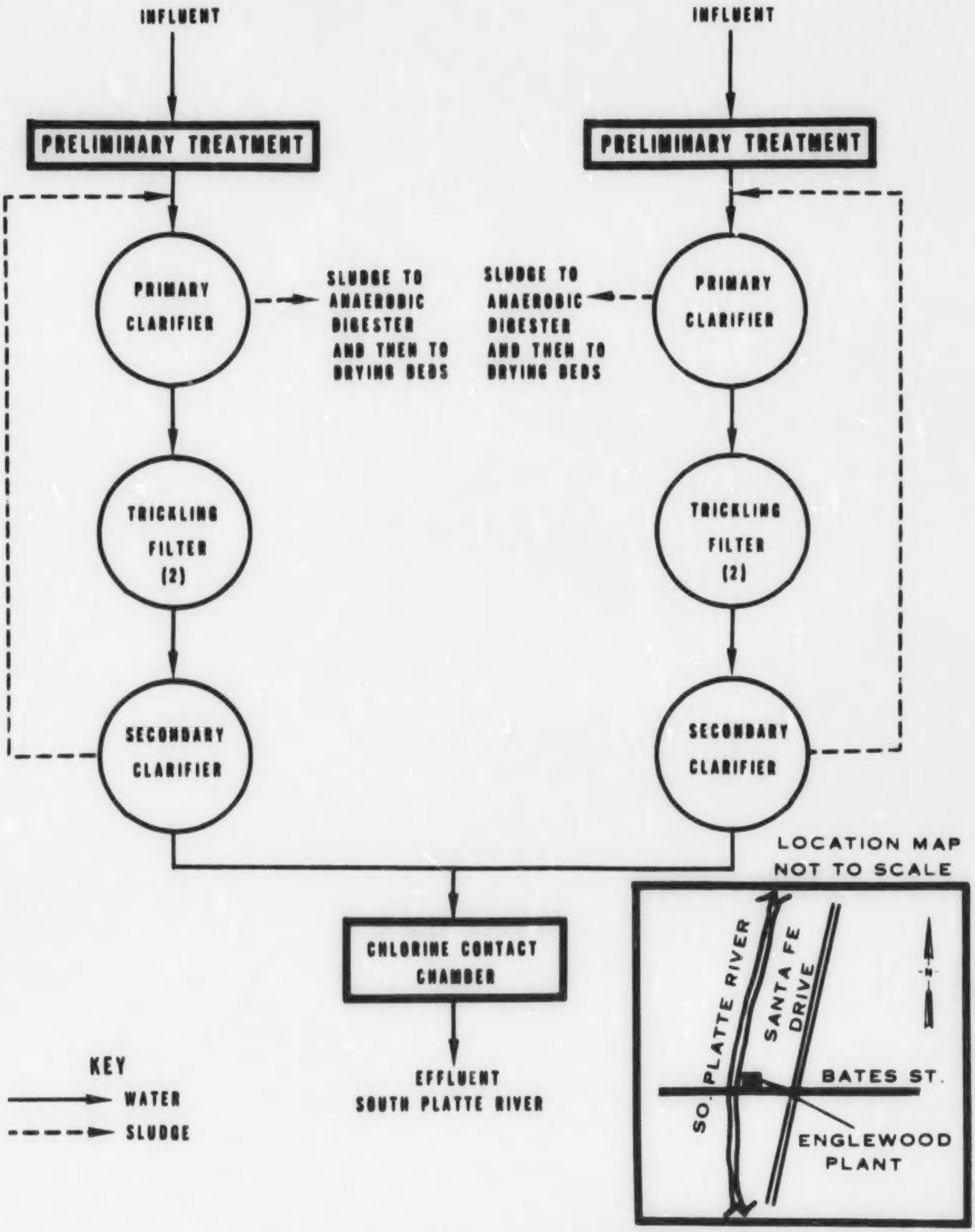
INFLUENT
INFLUENT
PRELIMINARY TREATMENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO ANAEROBIC DIGESTER AND THEN TO DRYING BEDS
SLUDGE TO ANAEROBIC DIGESTER AND THEN TO DRYING BEDS
PRIMARY CLARIFIER
TRICKLING FILTER (2)
TRICKLING FILTER (2)
SECONDARY CLARIFIER
SECONDARY CLARIFIER
CHLORINE CONTACT CHAMBER
EFFLUENT SOUTH PLATTE RIVER
KEY
WATER
SLUDGE
LOCATION MAP NOT TO SCALE
SO. PLATTE RIVER
SANTA FE DRIVE
N
BATES ST.
ENGLEWOOD PLANT

Figure 1. Wastewater Treatment Plant, Englewood

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
ENGLEWOOD WASTEWATER TREATMENT FACILITY
SEPTEMBER 21-25, 1971

Parameter[a]	Effluent before Chlorination		Effluent after Chlorination	
	Range	Average	Range	Average
Flow (mgd)			8.2-8.8	8.6
pH (S.U.)	7.1-8.9		7.4-8.6	
Temperature (°C)	14-18		15-19	
Conductivity (µmhos/cm)	1,050-1,800		1,200-1,500	
BOD (mg/l)	80-90	87	60-70	63
TOC (mg/l)	60-200	165	50-60	53
Total Solids (mg/l)	870-900	890	870-890	880
Suspended Solids (mg/l)	120-150	135	90[b]	
NH_3 (mg/l)	16-18	17	15-17	16
K_j-N (mg/l)	23-26	25	22-23	22
NO_2-NO_3 (mg/l)	0.03-0.96	0.53	0.73-0.96	0.86
Total P (mg/l)	6.6-8.0	7.4	5.6-7.0	6.1

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[a] Analyses for BOD, TOC, total solids, and suspended solids were performed on composite samples.

[b] This is a single sample.

TABLE 2

BACTERIOLOGICAL RESULTS
ENGLEWOOD WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
September 21, 1971	0815	<10	<10	0.2
	1140	310,000	2,200	0.0
	1430	19,000	120	
September 22, 1971	0925	160,000	1,100	0.9
	1305	>800,000	6,000	0.2
	2000	53,000	200	0.3
September 23, 1971	0625	5,700	360	
	1525	1,300	<10	

The average BOD and suspended solids load discharged to the river were equivalent to 4,530 and 6,340 pounds per day, respectively. Disinfection was inadequate for part of the time [Table 2].

Currently being proposed is a regional treatment facility designed to serve the communities of Englewood and Littleton.[2/] Though only in the discussion stage, the proposal calls for continued operation of the existing Littleton plant (4.5 mgd capacity) plus re-activation of the original Littleton facility (one mgd). Flows in excess of 5.5 mgd would be diverted to the Englewood municipal facility. All future expansion would be at the Englewood site.

Maintenance of adequate dissolved oxygen, i.e. 6.0 mg/1,* at low flow conditions requires the wastewater effluent to contain a BOD no greater than 25 mg/1.

D. SUMMARY AND CONCLUSIONS

1. The Englewood plant was undergoing modifications and expansion during the September, 1971, survey. Thus, adequate treatment was not provided -- the effluent BOD was more than six times that observed during studies conducted in 1967. Disinfection was adequate a portion of the time.

2. To meet water quality standards at low flow conditions will require that the Englewood facility produce an effluent biochemical oxygen demand containing no greater than 25 mg/1.

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* This is the State of Colorado dissolved oxygen standard for cold water fisheries.

E. RECOMMENDATIONS

It is recommended that:

1. The biochemical oxygen demand and suspended solids in the Englewood wastewater effluent not exceed 25 mg/l or 2500 lb/day of each (at 12 mgd), whichever is less.

2. The effluent contain no greater than 1000 fecal coliform bacteria/100 ml.

F. REFERENCES

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin* , U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December, 1965. Appendix B.

2/ *Littleton and Englewood Look at Joint Sewer Project* , Littleton Independent, 84th year, No. 45, Littleton, Colorado, Thursday, May 25, 1972.

FORT COLLINS WASTEWATER TREATMENT PLANTS
FORT COLLINS, COLORADO

A. INTRODUCTION

The City of Fort Collins operates two wastewater treatment plants. Plant No. 1, located on the Cache la Poudre River (RM 249.0/44.1), is a high-rate trickling filter plant designed for 4.5 mgd. The plant was originally constructed in 1948, expanded in 1958 and again in 1961. Chlorination was added in 1968. Plant No. 2, also located on the Cache la Poudre River (RM 249.0/40.2), is a conventional activated sludge plant designed for 4.8 mgd. It was constructed in 1968 with an EPA grant, at a cost of 1.2 million dollars.

The superintendent of sewers and a laboratory technician serve both Plants No. 1 and No. 2. The staff for each plant includes a chief operator, two operators, and two utility men. Both plants are manned continuously. The operating budget in 1971 for these two plants was $158,000.

Studies conducted in 1965 and 1966,[1/] indicate that the BOD removal efficiencies for Plant No. 1 varied from 65 percent to 77 percent. Disinfection of the effluent was not provided. Additional waste treatment and adequate disinfection was recommended at that time.

Both plants were evaluated by the National Field Investigations Center-Denver from January 31 through February 2, 1972. Charles Liquin, Director of Public Works, provided information and assistance.

B. WASTE TREATMENT FACILITIES

1. Fort Collins Plant No. 1 - The plant is designed for 4.5 mgd. The principal components of the plant [Figure 1] are:

a) preliminary treatment -- bar screen, grit chamber and comminutor;

b) primary treatment -- two clarifiers (each 85 ft in diameter and 10.5 ft deep) designed for a detention time of 2.4 hr at a flow of 4.5 mgd;

c) secondary treatment -- high-rate trickling filter (130 ft in diameter and 5 ft, 9 in deep) and a rectangular clarifier (63 ft wide, 105 ft long, and 8.5 ft deep) designed for a maximum flow of 8.9 mgd;

d) disinfection -- chlorine contact chamber with a detention time of 15 minutes at 4.5 mgd; and

e) digestion -- two primary and two secondary anaerobic digesters; digested sludge is removed to drying beds.

2. Fort Collins Plant No. 2 - The plant is designed for 4.8 mgd. The principal components of the plant [Figure 2] are:

a) preliminary treatment -- bar screen, grit chamber, and comminutor;

b) primary treatment -- two clarifiers (65 ft in diameter and 8 ft deep) with detention time of 1.8 hr at design flow;

c) secondary treatment -- activated sludge unit, with two aeration tanks (each with a volume of 450,000 gal) that each have mechanical aerators and a detention time of 4 hr at design flow, and two clarifiers (65 ft in diameter and 8 ft deep) with detention time of 1.8 hr at design flow;

d) disinfection -- chlorine contact chamber with a detention time of 15 minutes at design flow; and

e) digestion -- two-stage anaerobic digestion, digested sludge is removed to drying beds.

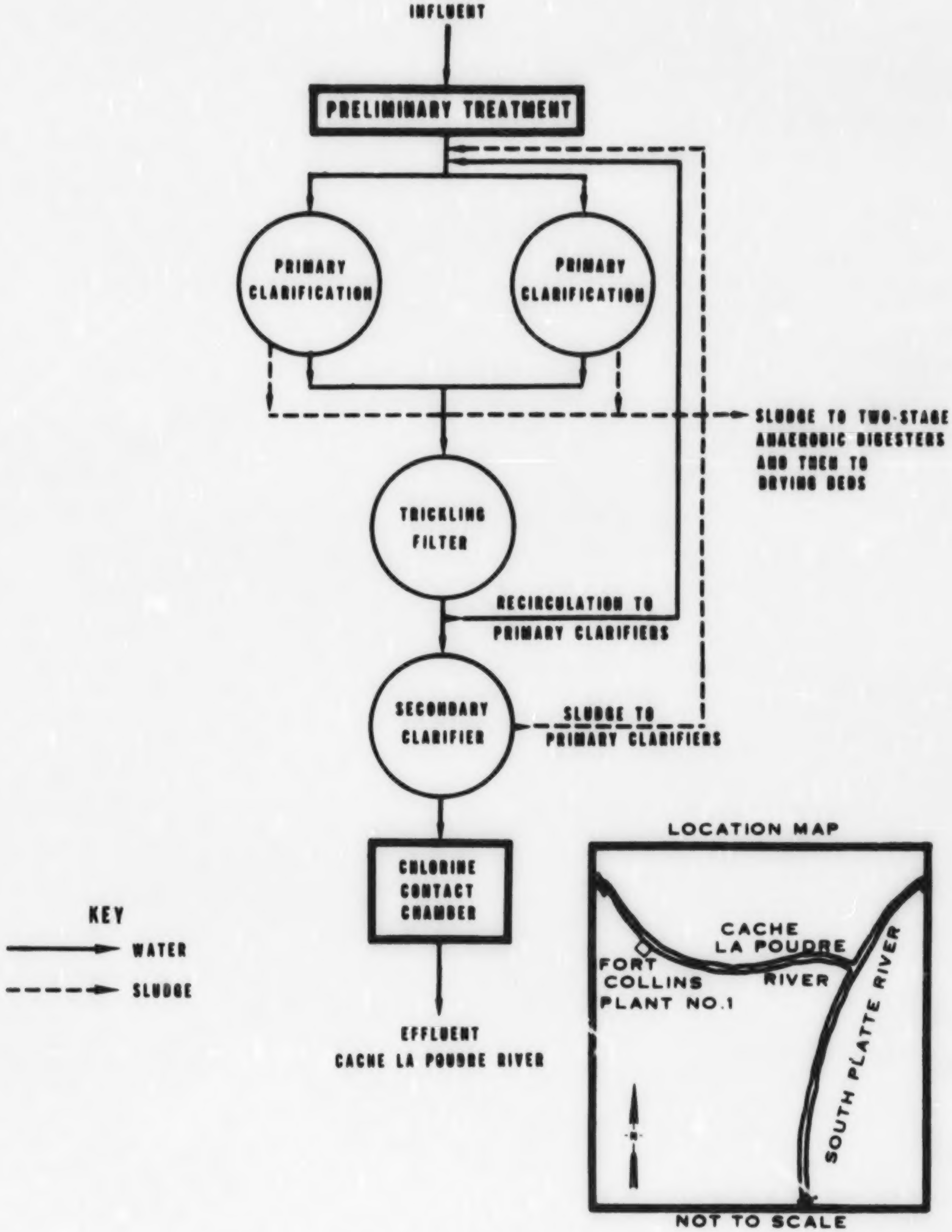
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFICATION
PRIMARY CLARIFICATION
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS
TRICKLING FILTER
RECIRCULATION TO PRIMARY CLARIFIERS
SECONDARY CLARIFIER
SLUDGE TO PRIMARY CLARIFIERS
CHLORINE CONTACT CHAMBER
EFFLUENT
CACHE LA POUDRE RIVER
KEY
WATER
SLUDGE
LOCATION MAP
CACHE LA POUDRE RIVER
FORT COLLINS PLANT NO.1
SOUTH PLATTE RIVER
N
NOT TO SCALE

Figure 1. Wastewater Treatment Plant No.1 - Fort Collins

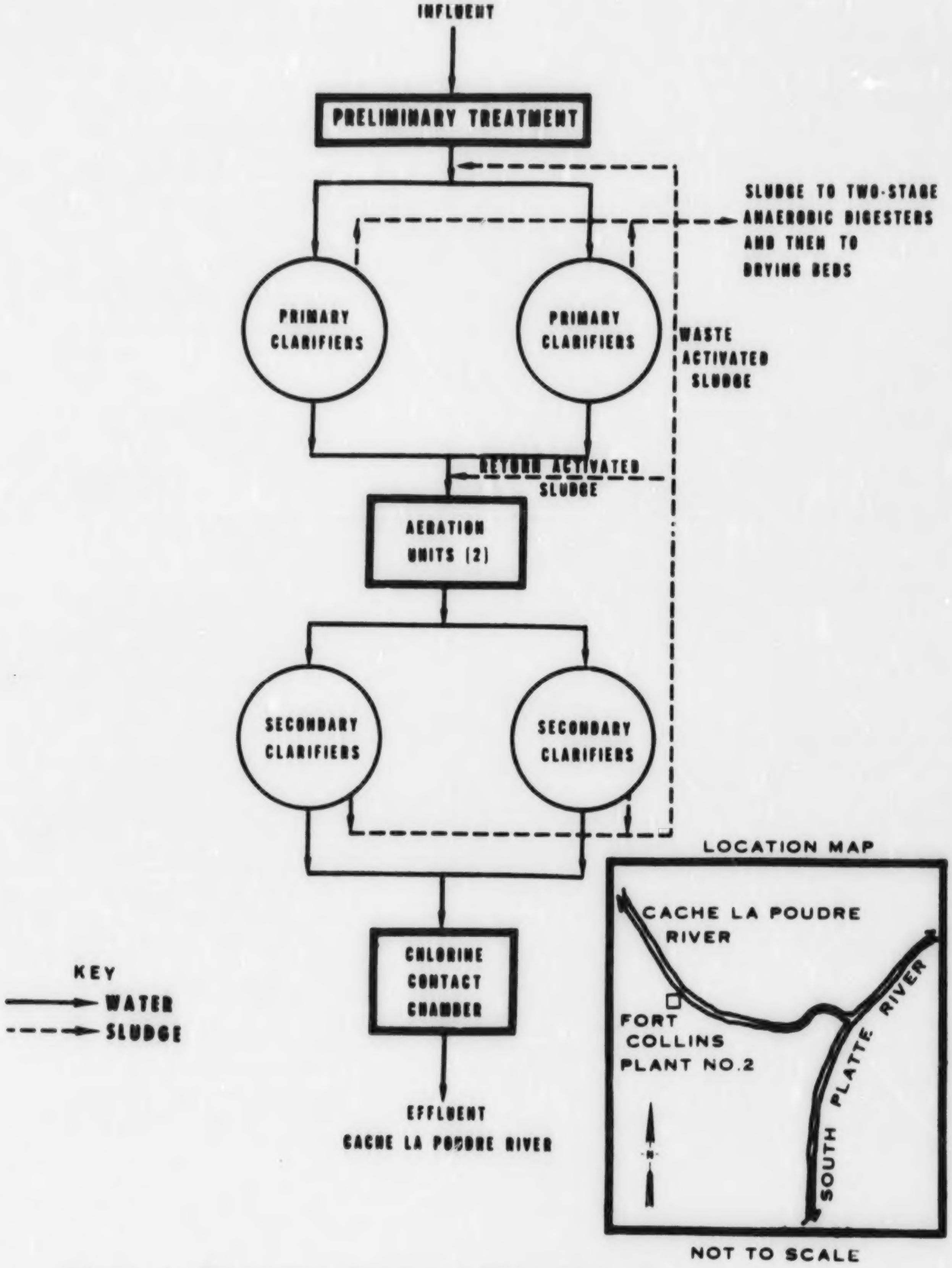
INFLUENT
PRELIMINARY TREATMENT
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS
PRIMARY CLARIFIERS
PRIMARY CLARIFIERS
WASTE ACTIVATED SLUDGE
RETURN ACTIVATED SLUDGE
AERATION UNITS (2)
SECONDARY CLARIFIERS
SECONDARY CLARIFIERS
CHLORINE CONTACT CHAMBER
EFFLUENT
CACHE LA POUDRE RIVER
KEY
WATER
SLUDGE
LOCATION MAP
CACHE LA POUDRE RIVER
FORT COLLINS PLANT NO.2
SOUTH PLATTE RIVER
N
NOT TO SCALE

Figure 2. Wastewater Treatment Plant No.2 , Fort Collins

Laboratory facilities have been provided at Plant No. 2. Influent and effluent analysis (BOD, pH, settleable solids, and suspended solids) are run for both Plant No. 1 and Plant No. 2 in this laboratory. In addition chlorine residuals, volatile acids, and alkalinity are also checked periodically. Process control analysis on the activated sludge unit, Plant No. 2, are run daily.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the influent and effluent (before chlorination) were collected at both plants during January 31 through February 2, 1972. The samples were collected using SERCO automatic samplers and composited on a flow weighted basis from measurements taken at the headworks. Temperature, pH, and conductivity were measured periodically at each sampling location. Periodic grab samples were collected for bacteriological analyses and chlorine residual measurements. [The results of the chemical and bacteriological analyses are contained in Tables 1-4.]

At Plant No. 1 BOD removal efficiency ranged from 66 to 75 percent, below the minimum required by the State of Colorado. The efficiency of suspended solids removal ranged from 0 to 96 percent [Table 1]. Flows varied from 2.3 to 5.2 mgd reaching a level of 15 percent above design capacity at peak flows. The peak flows would cause solids to carry over the clarifiers thereby reducing overall plant efficiency. Disinfection of the effluent was not adequate as chlorine residuals varied from 0.0 to 0.5 mg/1 [Table 3].

Plant No. 2 was providing adequate treatment under state criteria.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
FORT COLLINS WASTEWATER TREATMENT FACILITY NO. 1
JANUARY 31-FEBRUARY 2, 1972

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			3.62-3.98	3.86	
pH (S.U.)	6.9-7.5		6.9-7.4		
Temperature (°C)	10-11.5		8-11		
Conductivity (μmhos/cm)	600-2,850		600-1,000		
BOD (mg/1)	185-200	193	52-66	59	66-75
COD (mg/1)	341-777	609	135-195	158	60-79
Total Solids (mg/1)	872-1,440	1,164	378-586	495	40-68
Suspended Solids (mg/1)	202-941	454	41-240	110	0-96

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[a] Analyses for BOD, COD, total solids, and suspended solids were performed on composite samples.

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
FORT COLLINS WASTEWATER TREATMENT FACILITY NO. 2
JANUARY 31-FEBRUARY 2, 1972

Parameter[a]	Influent		Effluent		Percent
	Range	Average	Range	Average	Removal
Flow (mgd)			3.4-4.1	3.9	
pH (S.U.)	7.1-9.5		6.1-6.8		
Temperature (°C)	10-13		8.5-9.0		
Conductivity (µmhos/cm)	500-800		580-625		
BOD (mg/l)	200-230	218	35-42	39	79-84
COD (mg/l)	795-955	888	71-168	132	79-83
Total Solids (mg/l)	609-793	717	315-353	339	43-60
Suspended Solids (mg/l)	324-376	346	21-42	30	89-93

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[a] Analyses of BOD, COD, total solids, and suspended solids were performed on composite samples.

TABLE 3

BACTERIOLOGICAL RESULTS
FORT COLLINS WASTEWATER TREATMENT FACILITY NO. 1

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
January 31, 1972	1030	410,000	500	0.5
	1500	430,000	2,400	0.1
February 1, 1972	0930	81,000	300	0.0
	1300	130,000	900	0.1
February 2, 1972	0925	74,000	620	0.3
	1435	59,000	2,000	

TABLE 4

BACTERIOLOGICAL RESULTS
FORT COLLINS WASTEWATER TREATMENT FACILITY NO. 2

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
January 31, 1972	1135	3,200	100	0.9
	1525	5,000	<100	
February 1, 1972	0900	270	4	0.5
	1335	<100	<4	0.9
February 2, 1972	0850	70	<10	0.9
	1415	2,000	<1,000	

BOD removal efficiencies ranged from 79 to 84 percent (average of 82 percent). Although the chlorine residuals were less than 1 mg/l (range of 0.5 to 0.9 disinfection of the effluent was adequate (fecal coliform bacteria density ranged from <4 to <1,000/100 ml).

A stream survey in September 1971[2/] showed that the wastewater discharged by the two Fort Collins treatment plants degraded the water quality and stream bed environment of the Cache la Poudre River. Improved treatment at these plants appears necessary.

In determining pollution control requirements the low flow conditions were examined for the Cache la Poudre River for the period, 1961-1970. The seven-day, ten-year low flow downstream from Fort Collins was 24 cfs before receiving wastes from the two municipal plants. To prevent violation of water quality standards in the river (i.e., to maintain a DO concentration of not less than 5 mg/l) requires that the effluent from each of these two treatment plants contain no more than 25 mg/l (1000 lb/day) each of BOD and suspended solids.

D. SUMMARY AND CONCLUSIONS

1. The BOD removal efficiency at Fort Collins Plant No. 1 did not meet the Colorado requirements for secondary treatment.
2. Disinfection of the effluent was not adequate at Plant No. 1.
3. Water quality degradation occurred downstream from the discharges of the two plants.
4. Low flow conditions require that the BOD and suspended solids concentrations in the effluent at each plant not exceed 25 mg/l each or 1000 lb/day each at design flow to prevent water quality degradation in the Cache la Poudre River.

E. RECOMMENDATIONS

It is recommended that:

1. The treatment facilities at each plant be upgraded to provide that the biochemical oxygen demand and suspended solids in the effluents not exceed 25 mg/l or 1,000 lb/day of each whichever is less.

2. Adequate disinfection of the Plant No. 1 effluent be provided.

F. REFERENCES

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

2/ *Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72*, National Field Investigations Center-Denver and Region VIII, Denver, Colorado, April 1972.

FORT LUPTON WASTEWATER TREATMENT PLANT
FORT LUPTON, COLORADO

A. INTRODUCTION

The Fort Lupton treatment plant serves a permanent population of approximately 2,600 people and an additional 1,400 people during the summer and fall months. Discharge from this plant is to the South Platte River (RM 287.6). The plant is manned approximately two hours/day by a part-time operator. Industrial wastewater from the Fort Lupton Canning Company is also discharged to the municipal sewer during summer months.

In 1967[1/] a single grab sample, collected from the combined lagoon effluent, contained 20 mg/l of BOD and 21 mg/l of suspended solids.

An in-plant survey was conducted during the period September 27-29, 1971. Howard McWilliams, Plant Operator, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The treatment facility [Figure 1] consists of two lagoons operated in parallel. Each lagoon has an area of 14.5 acres and is operated at a depth of 5 ft. The retention time is approximately 150 days at present flow. Effluent from the canning company passes through screens prior to being discharged into the municipal sewer.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

A grab sample of the combined effluent from each lagoon was collected each day, September 28, 29, and 30, 1971. Temperature, pH, and conductivity were measured each time a sample was collected. Grab samples were also collected for bacteriological analysis. Visual observation showed adequate maintenance of the lagoon banks and the characteristic green water color was indicative of a properly operating lagoon.

The survey data [Table 1] indicate that the effluent BOD ranged from 20 to 40 mg/1, (average 30 mg/1 or 8 lb/day).

A review of the bacteriological results [Table 2] reveals that the wastewater receives adequate disinfection under State requirements. At present flow the lagoons provide 150 days detention time.

D. SUMMARY AND CONCLUSIONS

1. The treatment facility provides adequate treatment and disinfection of wastewaters under existing State requirements.

2. Wastes from the Fort Lupton Canning Company were not causing any adverse effects upon the operation of the lagoons.

E. REFERENCE

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-1967*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

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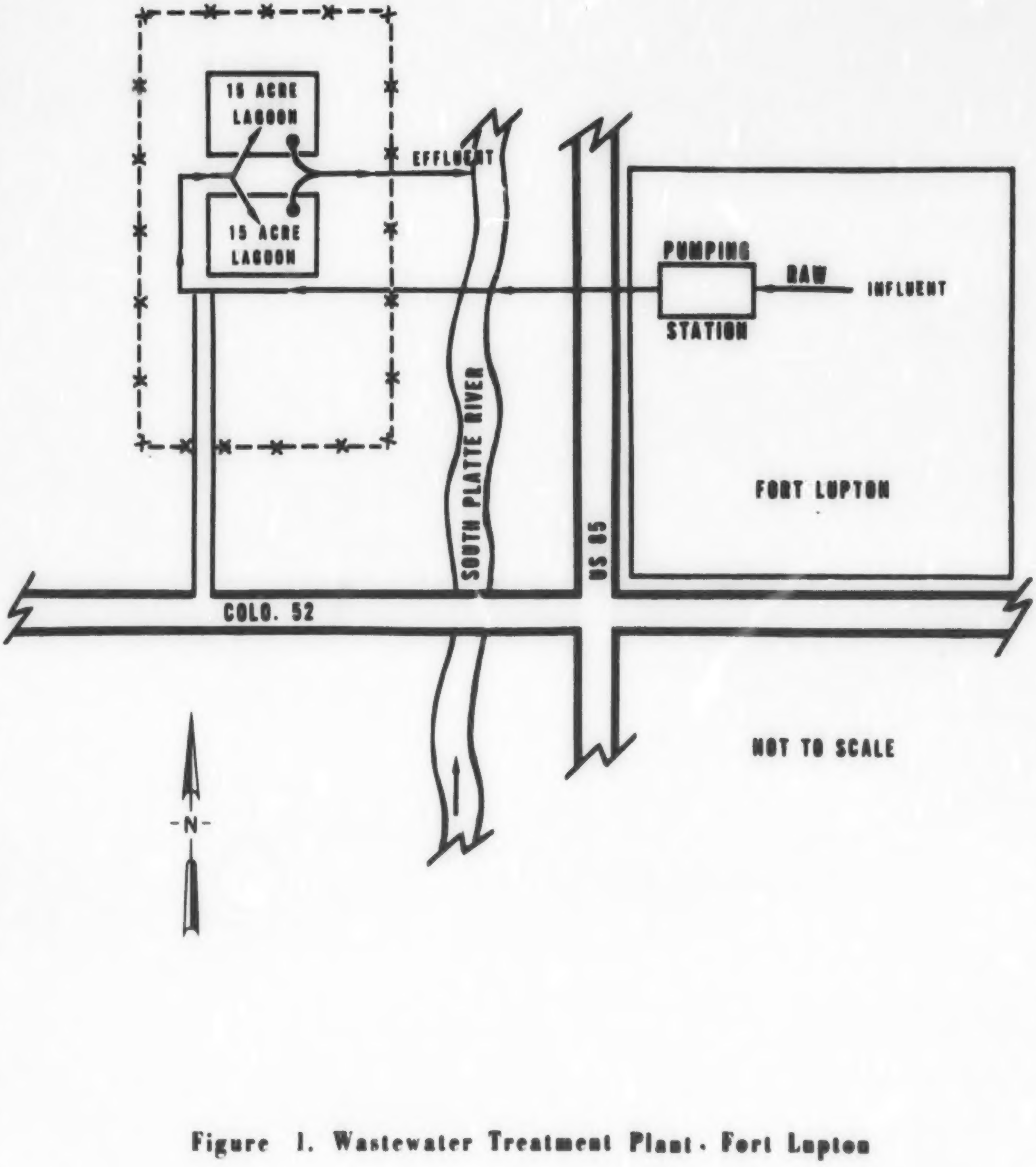
15 ACRE LAGOON
15 ACRE LAGOON
EFFLUENT
PUMPING STATION
RAW INFLUENT
SOUTH PLATTE RIVER
US 85
FORT LUPTON
COLO. 52
NOT TO SCALE
N

Figure 1. Wastewater Treatment Plant - Fort Lupton

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
FORT LUPTON WASTEWATER TREATMENT FACILITY
SEPTEMBER 27-30, 1971

Parameter	Effluent Range	Effluent Average
Flow (mgd)		0.032[a]
pH (S.U.)	8.8-9.6	
Temperature (°C)	12.0-14.0	
Conductivity (µmhos/cm)	2,200-2,400	
BOD (mg/l)	20-40	30
TOC (mg/l)	50-60	53
Total Solids (mg/l)	1,640-1,670	1,660
Suspended Solids (mg/l)	80-140	116
Total N (mg/l)	8.0-22	12.8
NH_3 (mg/l)	0.5-1.1	0.9
$NO_2 + NO_3$ (mg/l)	0.12-0.18	1.5
Total Phosphorus (mg/l)	3.0-3.4	3.3

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[a] This is a single value.

TABLE 2

BACTERIOLOGICAL RESULTS
FORT LUPTON WASTEWATER TREATMENT FACILITY

Date	Time	Effluent from North Lagoon		Effluent from South Lagoon	
		Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml
September 27, 1971	1445	2,700	1,900	23,000	3,100
September 28, 1971	0815	190,000	18,000	35,000	5,100
	1645	>80,000	16,000	77,000	33,000
September 29, 1971	1040	>80,000	8,200	43,000	12,000

FORT MORGAN WASTEWATER TREATMENT PLANT
FORT MORGAN, COLORADO

A. INTRODUCTION

The Fort Morgan wastewater treatment plant is located on the South Platte River (RM 195.2). The plant presently serves a population of about 7,600 people together with wastewater (approximately 1 mgd) discharged by American Beef Packers, Inc. The plant is manned eight hours/day by one operator. The primary units were constructed in 1956 with the addition of secondary treatment facilities in 1961.

In 1966,[1/] the Fort Morgan plant was treating an average flow of 1.5 mgd, below the design capacity of 2.0 mgd. The BOD removal efficiency was 87 percent. There was no provision for disinfection of the effluent.

A 1972 in-plant survey was conducted during the period, January 25 through 29. Jack Odor, city engineer; Henry Sells, Jr., plant superintendent; and Cecil Osborne, consulting engineer, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The present facilities are designed for a capacity of 2.0 mgd and a BOD loading of 4500 lb/day. The principal components [Figure 1] of the plant are:

1. Preliminary treatment -- two grit chambers, bar screen, and two comminutors with the grit chambers and bar screen cleaned manually;
2. Primary treatment -- two clarifiers (one 45 ft in diameter and 9 ft deep and the other 60 ft in diameter and 10 ft deep) with

a surface overflow rate (based on average flow) of 575 gal/ft^2 per day and detention time of three hours;

3. Secondary treatment -- two high-rate trickling filters operated in series (one 88 ft in diameter with 7 ft of rock media and the other 100 ft in diameter and 6 ft of rock media), and clarifier (52 ft in diameter and 10 ft deep) with a surface overflow rate of 900 gpd/ft^2 and detention time of 1.5 hr; and
4. Digestion -- two anaerobic digesters (one 45 ft in diameter and 23 ft deep and the other 65 ft in diameter and 28 ft deep) that are heated.

Construction of additional secondary facilities was underway with financing provided by the City of Fort Morgan and American Beef Packers, Inc. Because of a lack of funds the construction had been delayed. The additional facilities [Figure 1] include:

1. Two high-rate trickling filters (each 120 ft in diameter and 7 ft deep) to be operated in series;
2. Secondary clarifier (60 ft in diameter and 10 ft deep); and
3. Chlorination facilities including a contact chamber (20 ft by 40 ft by 8 ft) with a detention time of 23 minutes at a peak flow of 3 mgd. (Additional detention will be provided by the long outfall line to the South Platte River.)

Based on Colorado design criteria the new facility will increase the capacity of organic loading by 7900 lb of BOD/day to a total of 12,400 lb of BOD/day.

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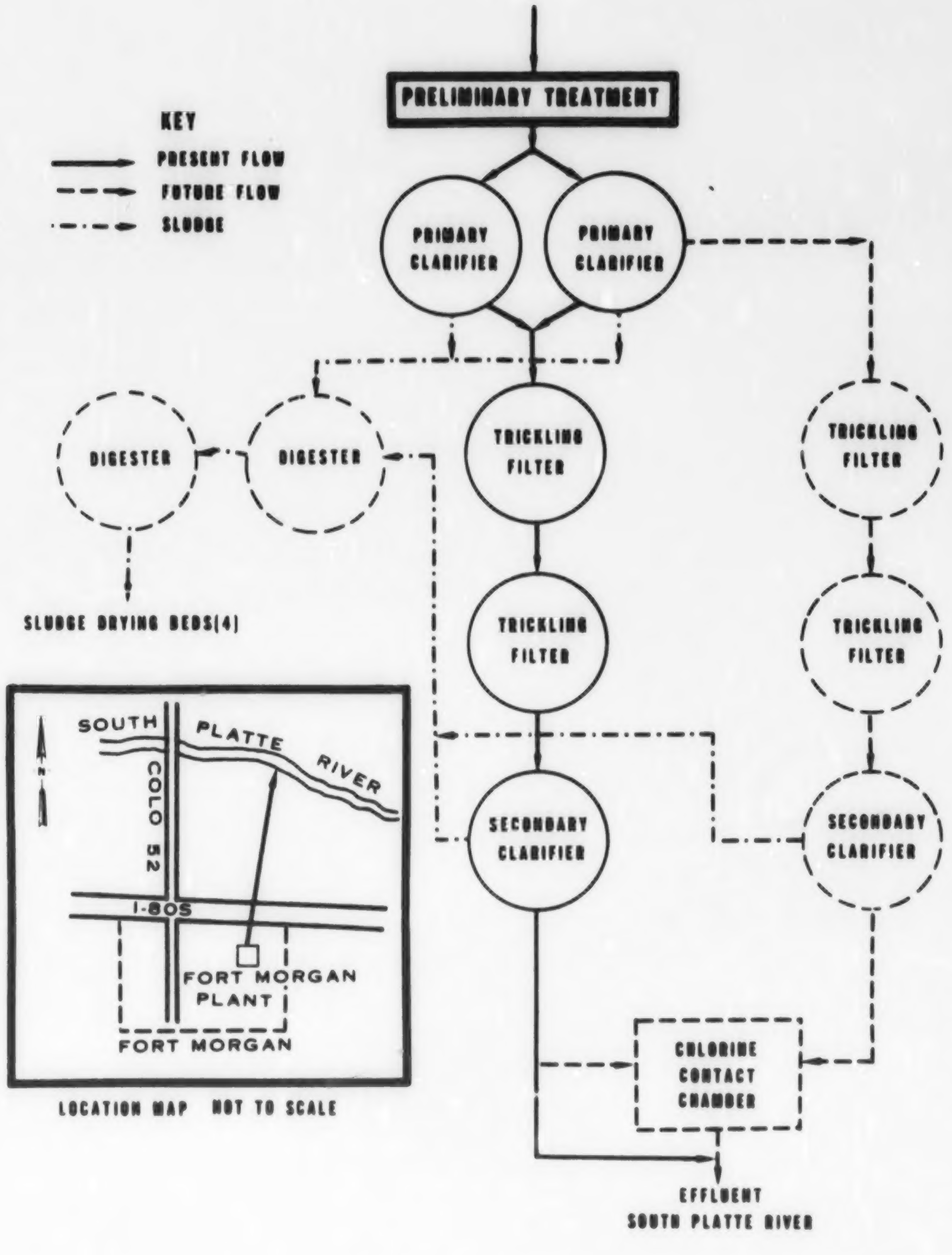
PRELIMINARY TREATMENT
KEY
PRESENT FLOW
FUTURE FLOW
SLUDGE
PRIMARY CLARIFIER
PRIMARY CLARIFIER
DIGESTER
DIGESTER
TRICKLING FILTER
TRICKLING FILTER
TRICKLING FILTER
TRICKLING FILTER
SLUDGE DRYING BEDS(4)
SOUTH PLATTE RIVER
COLO 52
I-80S
N
FORT MORGAN PLANT
FORT MORGAN
LOCATION MAP NOT TO SCALE
SECONDARY CLARIFIER
SECONDARY CLARIFIER
CHLORINE CONTACT CHAMBER
EFFLUENT
SOUTH PLATTE RIVER

Figure 1. Wastewater Treatment Plant . Fort Morgan

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composite samples of the influent and effluent were collected using SERCO automatic samplers on the dates, January 25, 26, and 28, 1972. All samples were composited on the basis of time. Temperature, pH, and conductivity were measured periodically at each sampling location and grab samples were collected for bacteriological analyses. Grab samples of the effluent from the American Beef Packers, Inc. were also collected daily for chemical analyses [Table 1].

The American Beef Packers, Inc. process from 1,000 to 1,400 head of beef daily, five days per week. Process wastewater, prior to being discharged to the municipal sewers, is given primary treatment. Water used to clean stock holding pens is discharged to the municipal sewers without any pretreatment. The estimated BOD load from the packing plant, calculated on grab sample analyses, was 13,700 lb/day. This comprises 90 percent of the total influent load (14,800 lb) received by the Fort Morgan plant.

The organic and hydraulic capacity of the Fort Morgan plant was exceeded during the 1972 survey. With the addition of two new trickling filters the organic loading of the plant will be increased to approximately 12,400 lb BOD/day. The present loading capacity is in excess of the expanded capacity.

Efficiencies of BOD and suspended solids removal [Table 2] ranged from 63-77 percent and 72-92 percent, respectively. The high strength waste from the packing company precludes proper operation of this municipal plant. The levels of BOD in the plant effluent, 160-220 mg/l,

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS AMERICAN BEEF PACKERS, FORT MORGAN, COLORADO

Parameter[a]	Effluent	
	Range	Average
Flow (mgd)	1.0 (estimate)	
BOD (mg/l)	1,100-2,700	1,640
COD (mg/l)	2,150-6,460	3.900
Total Sclids (mg/l)	7,630-53,700	31,400
Suspended Solids (mg/l)	3,140-29,800	12,600

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a/ All analyses were conducted on grab samples.

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
FORT MORGAN WASTEWATER TREATMENT FACILITY
JANUARY 26-29, 1972

Parameter[a/]	Influent		Effluent		Percent
	Range	Average	Range	Average	Removal
Flow (mgd)			2.30-2.82	2.55	
pH (S.U.)	7.5-8.2		7.5-7.8		
Temperature (°C)	19-22		10-15.5		
Conductivity (µmhos/cm)	1,400-4,000		2,400-4,000		
BOD (mg/1)	600-790	697	160-220	190	63-77
COD (mg/1)	1,130-3,990	2,160	291-439	383	61-93
Total Solids (mg/1)	3,380-4,070	3,820	2,860-2,950	2,900	15-28
Suspended Solids (mg/1)	340-1,570	834	66-129	94	72-92

[a/] Analyses of BOD, COD, total solids, and suspended solids are performed on composite samples.

are excessive. The BOD and suspended solids levels should be about 30 mg/l. Additional pre-treated by the packing company (level of 250 mg/l each of BOD and suspended solids in the effluent), expanded facilities, and improved operation at the Fort Morgan municipal plant are required to achieve the 30 mg/l level.

Fecal-coliform bacteria densities ranged from 310,000-720,000/100 ml [Table 3] because disinfection of the effluent by chlorination was not being practiced.

During the survey the following observations were made:

1. Grit chambers were not operated adequately. The plant has two grit chambers that are employed in an alternating manner, with only one unit in service at a time. A single grit chamber is used for one week and then the flow is diverted through the other unit while the first is cleaned. However, because of the large amount of grit carried by the plant influent, the grit chamber fills rapidly allowing the incoming grit to carry over into the primary clarifier. The grit is then pumped with the sludge to the digestor, reducing the effective digestor capacity. In addition, wastewater trapped within the grit filled chamber was pumped to a manhole that discharges it to the South Platte River. Grit removed from the chamber is spread within the municipal plant area.
2. No continous flow recording instruments were installed at the municipal plant. The average daily flow was obtained by averaging five staff gage readings taken from a Parshall flume.

TABLE 3

BACTERIOLOGICAL RESULTS
FORT MORGAN WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml
January 26, 1972	1215	2,700,000	720,000
	1315	1,700,000	550,000
January 27, 1972	1145	5,300,000	310,000
	1215	9,100,000	640,000
January 28, 1972	1045	3,000,000	380,000
	1215	3,500,000	580,000

3. The municipal plant operators have not received any formal training in treatment plant operation.
4. Routine maintenance and operation of the municipal facilities were inadequate.
5. Laboratory facilities were provided for the performance of chemical tests of wastewater quality. Analyses were being performed to determine the quality of the influent and effluent from American Beef Packers, Inc. Tests performed daily include BOD and settleable solids. Additional laboratory analyses are required to insure efficient operation of the municipal treatment facilities.

D. SUMMARY AND CONCLUSIONS

1. The Fort Morgan wastewater treatment plant was both hydraulically and organically overloaded. It did not meet the State of Colorado requirements for secondary treatment and disinfection. Moreover, 80 percent BOD removal from the wastewater load received would be inadequate.

2. American Beef Packers, Inc. provides primary treatment to their process wastewaters; but does not give any treatment to stock pen washings. The high strength wastes from this plant constitutes the majority (90 percent) of the waste load entering the Fort Morgan plant. American Beef Packers, Inc. is the cause of the Fort Morgan plant's organic overloading.

E. RECOMMENDATIONS

It is recommended that:

1. Disinfection of the effluent from the Fort Morgan wastewater plant be implemented immediately.

2. The effluent contain no more than 30 mg/l each of suspended solids and biochemical oxygen demand.

3. The present expansion program be completed by January 1, 1973.

4. The wastewaters from the American Beef Packers, Inc. be pretreated such that the biochemical oxygen demand and suspended solids levels are comparable to domestic sewage (250 mg/l), with the total loads of each not to exceed 2100 lb/day.

5. The municipal plant install an adequate flow-recording device by January 1, 1973.

6. Operation be modified to provide for better grit removal; wastewater removed from the grit chamber be diverted to the headworks of the plant.

7. The plant operators receive training by attendance at an operater school and by on-the-job training.

F. REFERENCE

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

JULESBURG WASTEWATER TREATMENT PLANT
JULESBURG, COLORADO

A. INTRODUCTION

The Julesburg wastewater treatment plant serves approximately 1,850 people. The effluent from the standard rate trickling filter plant flows through a polishing pond to the South Platte River (RM 86.9). The original wastewater treatment facility was constructed in 1958, and designed for a capacity of 0.295 mgd; the polishing pond was added in 1968.

In 1966[1/] the Julesburg wastewater treatment facility had major operational problems that resulted in the discharge of raw sewage and primary clarifier effluent to the South Platte River. Disinfection of the effluent was not being provided.

An in-plant survey was conducted during a three-day period, October 3-5, 1971. Dean Gilliard, city clerk, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The principal components of the system [Figure 1] are:

1. Preliminary treatment -- bar screen, grit chamber, and comminutor;
2. Primary treatment -- rectangular clarifier (12 ft by 44 ft, with a depth of 7 ft) which has, at design flow, a detention time of two hours, surface loading rate of 200 gpd/ft^2, and overflow rate of 10 gpm/ft;
3. Secondary treatment -- trickling filter (72 ft in diameter and 7 ft deep) and rectangular clarifier (8 ft by 44 ft and a 7 ft depth) that is designed for a surface loading rate of 838 gpd/ft^2;

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4. Disinfection and polishing -- lagoon (490 ft by 229 ft) with an operating depth that varies from 4 to 7 ft providing a detention time of 21 days at the greatest depth; and
5. Digestion -- one anaerobic digestor (40 ft in diameter by 24 ft deep); digested sludge is placed in drying beds.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the influent and the effluent were collected using SERCO automatic samplers. Samples were composited on a flow weighted basis from measurements obtained at the headworks. Periodic measurements were made of temperature, pH, and conductivity. Grab samples were also collected periodically for bacteriological analyses.

During the survey, the following visual observations were made.

1. The grit chamber, the wet well, and the weirs on the primary and secondary clarifiers had not been cleaned for some period.

2. The standard-rate trickling filter is not receiving sufficient flow to rotate the arms properly. Re-circulation was not provided and biota growth on the rock media was minimal.

3. The lagoon has not been maintained. The vegetation on the lagoon banks should be cut to prevent insect problems.

4. The influent and effluent discharge lines are improperly placed in the lagoon. With the present system there is a potential for short circuiting of flow, thus reducing the effective detention time of the lagoon.

5. The city clerk also functions as operator, but has not received formal training in the operation of this facility. It is estimated that

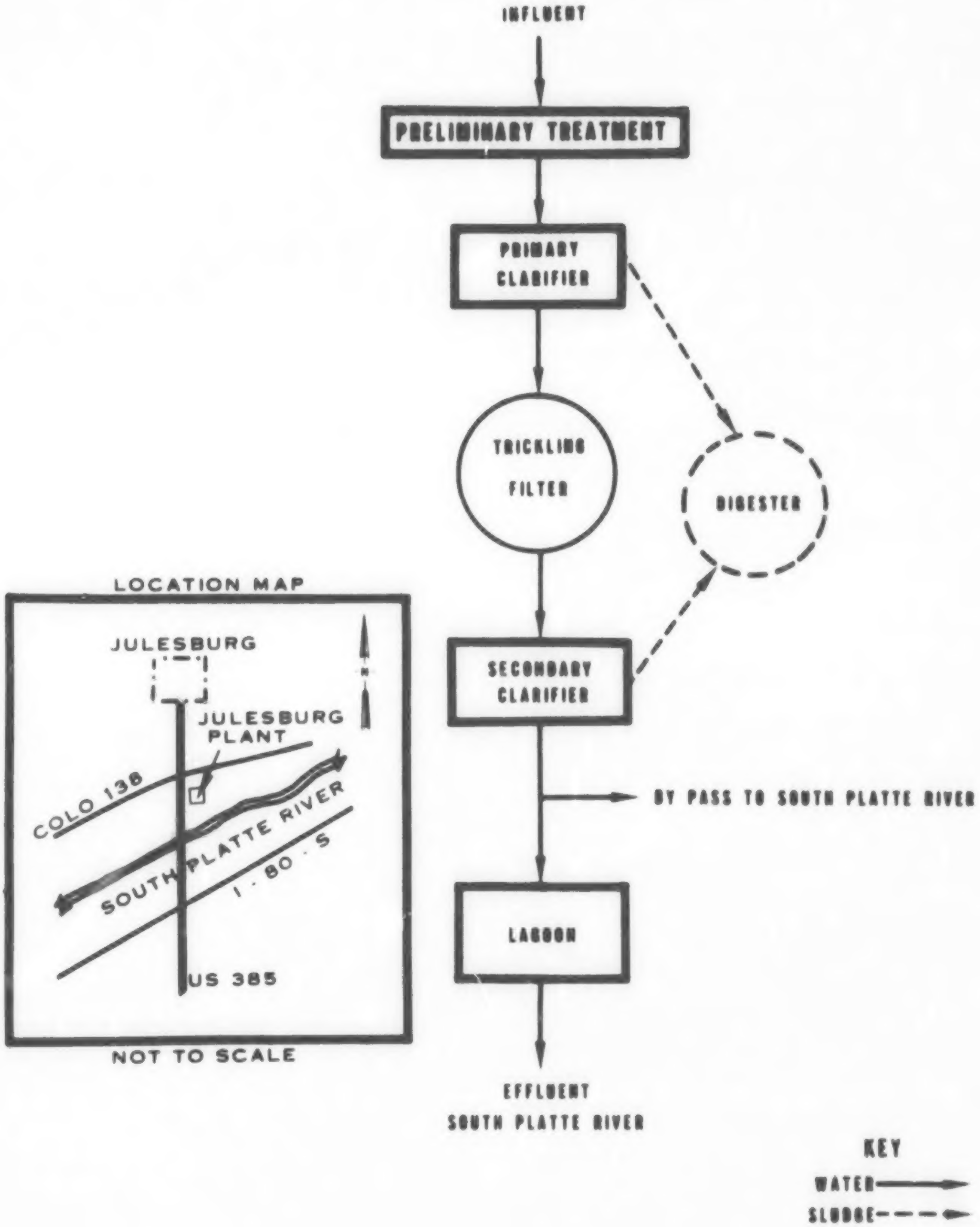
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
TRICKLING FILTER
DIGESTER
SECONDARY CLARIFIER
BY PASS TO SOUTH PLATTE RIVER
LAGOON
EFFLUENT
SOUTH PLATTE RIVER
KEY
WATER
SLUDGE
LOCATION MAP
JULESBURG
JULESBURG PLANT
N
COLO 138
SOUTH PLATTE RIVER
I - 80 - S
US 385
NOT TO SCALE

Figure 1. Wastewater Treatment Plant - Julesburg

only ten hours per week is devoted to operation and routine maintenance of the plant.

6. Essentially no laboratory equipment is available at this plant. Limited laboratory analysis are performed periodically by the Northeast Colorado Health Department.

The 1971 survey data [Table 1] shows that the BOD removal efficiency varied from 43 to 84 percent, with an average of 69 percent. The efficiency was equal to or greater than 80 percent on two days of the survey. On one of the days a lift station malfunctioned, causing a back-up of wastewater in the sewers. After the station became operable, a surge of heavy flow into the plant caused "scouring" in the primary and secondary clarifiers. As noted earlier, the short circuiting in the lagoon is possible because of relative locations of the influent and effluent lines.

The inadequacy in the present disinfection procedures is reflected by the total and fecal coliform bacteria densities [Table 2] that ranged from 43,000 to 830,000/100 ml and from 1,900 to 260,000/100 ml, respectively. The State of Colorado requires a minimum of 30 days retention time if polishing ponds follow mechanical plants and are used for disinfection. If the lagoon is operated at the maximum depth of 7 ft, the theoretical detention time is 21 days.

D. SUMMARY AND CONCLUSIONS

1. The BOD removal efficiency was greater than 80 percent two of the three days sampled. The removal efficiency dropped to 43 percent on the day a lift station malfunctioned.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
JULESBURG WASTEWATER TREATMENT FACILITY
OCTOBER 3-5, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			0.187-0.215	0.200	
pH (S.U.)	7.8-8.7		7.9-8.3		
Temperature (°C)	11.0-21.0		10.5-15.5		
Conductivity (µmhos/cm)	1,400-2,600		1,700-1,900		
BOD (mg/l)	140-180	155	30-80	45	43-84
TOC (mg/l)	200-620	360	50-60	57	75-90
Total Solids (mg/l)	1,410		1,470		
Suspended Solids (mg/l)	690		60		
Total N (mg/l)			18-22	20	
NH_3 (mg/l)			10-20	13	
$NO_2 + NO_3$ (mg/l)			0.16-0.54	0.38	
Total P (mg/l)			8-11	9	

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[a] Analyses of BOD, TOC, total solids, suspended solids, Total N, NH_3, $NO_2 + NO_3$, and Total P were performed on composite samples.

TABLE 2

BACTERIOLOGICAL RESULTS
JULESBURG WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml
September 27, 1971	0815	530,000	57,000
	1220	400,000	20,000
September 28, 1971	0755	680,000	260,000
	1220	>800,000	41,000
September 29, 1971	0640	>80,000	54,000
	1030	>80,000	34,000
October 3, 1971	0745	550,000	88,000
	1425	43,000	20,000
October 4, 1971	0835	830,000	1,900
	1440	>80,000	12,000
October 5, 1971	0840	600,000	58,000

2. Adequate disinfection was not provided.

3. Operation and maintenance of the plant was inadequate. Operator training is needed.

RECOMMENDATIONS

It is recommended that:

1. Operation of the plant and sewer system be improved to provide an effluent containing biochemical oxygen demand and suspended solids each no more than 30 mg/1.

2. The effluent receive adequate disinfection and contain no more than 1000 fecal coliform bacteria/100 ml at any time.

3. The plant operator be provided training in the operation and maintenance of the plant by attendance at an operator school and be provided on-the-job taining.

4. Operation of the trickling filter be modified to include recirculation of effluent.

5. Maintenance practices be improved including proper care of lift stations and clarifiers.

F. REFERENCE

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

LITTLETON WASTE TREATMENT PLANT
LITTLETON, COLORADO

A. INTRODUCTION

The Littleton plant, located on the South Platte River (RM 327.6), serves, at the present time, a population of at least 26,000 persons. The municipal facility is currently staffed by a plant superintendent, an assistant plant superintendent who also performs all the laboratory analysis, and three plant operators. It is manned continuously. The municipal plant (capacity, 4.5 mgd) was constructed in 1955 and 1959, replacing a facility which had one mgd wastewater treatment capacity.

An evaluation of the plant, in 1964,[1/] revealed that adequate secondary treatment was being provided, except for disinfection. Infiltration, during the summer months, in the older portion of the collection system caused flows to increase, by approximately one mgd, and become greater than those in the winter months.

Chlorination facilities were installed in this plant and became operational by July 1968.

The plant was again evaluated from September 20 through 25, 1971, in order to determine treatment effectiveness. Gail Mullis, plant superintendent, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The present treatment facilities [Figure 1] consist of the following:

1. Preliminary treatment -- grit chamber, bar screen, and comminutor.
2. Primary treatment -- clarifier (80 ft in diameter, 8 ft side water depth (SWD)) that is designed for a detention time of two hours at 4.5 mgd.

3. Secondary treatment -- two high-rate trickling filters (each 100 ft in diameter with one 5.5 ft and the other 5 ft depth) designed for a hydraulic capacity of 11.9 mgd and an organic capacity equivalent to approximately 4,600 lb BOD/day; one clarifier (100 ft in diameter by 8.5 ft SWD) designed for about 6.9 mgd.
4. Disinfection -- chlorination in the outfall line (0.5 mile in length), providing contact time of 15 min at 5.5 mgd.
5. Sludge digestion -- two-stage anaerobic digesters; digested sludge is removed to drying beds.

Laboratory analyses are routinely performed on both the influent and effluent for BOD and suspended, settleable, and volatile-suspended solids. The pH, volatile acids, and alkalinity measurements are made on the digested sludge. Complete records are maintained of the operational performance of this municipal waste treatment plant.

Additional treatment capacity, about one mgd, is available if the City of Littleton were to employ the original facility, a trickling filter plant, currently not in use.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the influent and the effluent before chlorination were collected from September 21 through 24, 1971, using SERCO automatic samplers. Samples of the effluent after chlorination were collected manually by plant personnel over the same time period. All samples were composited on a flow weighted basis. The pH, temperature, and conductivity were measured periodically at all three points. Grab samples of the effluent, at the point of discharge to the South

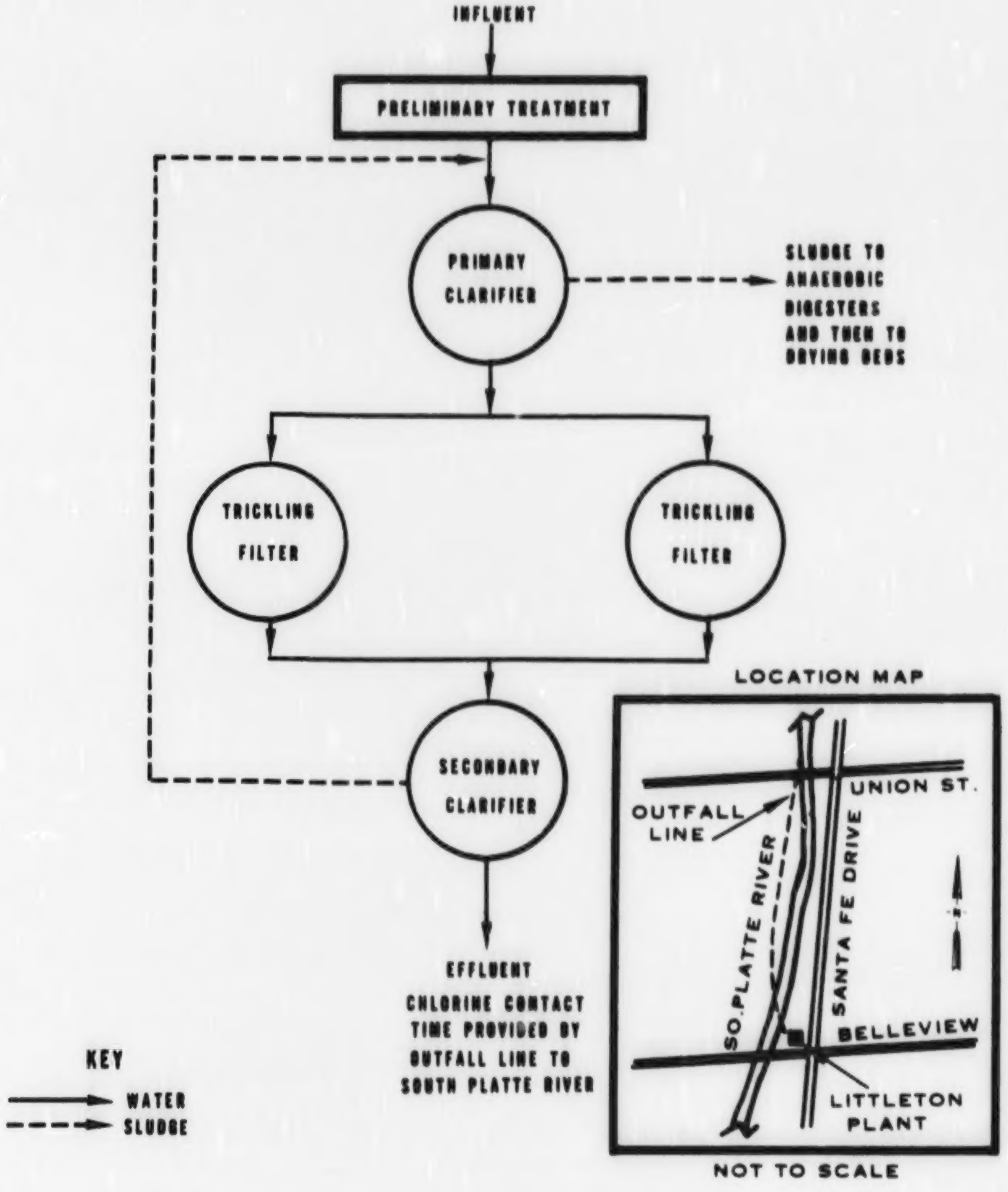
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS
TRICKLING FILTER
TRICKLING FILTER
SECONDARY CLARIFIER
EFFLUENT
CHLORINE CONTACT TIME PROVIDED BY OUTFALL LINE TO SOUTH PLATTE RIVER
KEY
WATER
SLUDGE
LOCATION MAP
UNION ST.
OUTFALL LINE
SO. PLATTE RIVER
SANTA FE DRIVE
N
BELLEVIEW
LITTLETON PLANT
NOT TO SCALE

Figure 1. Wastewater Treatment Plant, Littleton

Platte River, were collected for chlorine residual measurements and for bacteriological analyses [Table 1].

A review of the data in Table 1 shows that chlorination was adequate as fecal coliform bacteria densities were less than 1000/100 ml except on one occasion (2600/100 ml).

The BOD removal efficiency was determined before and after chlorination [Table 2]. Prior to chlorination the efficiency ranged from 73-82 percent; after chlorination the range was 75-80 percent. The State of Colorado requires a minimum BOD removal of 80 percent. The suspended solids removal efficiency averaged 64 percent after chlorination. As mentioned previously, infiltration increases flows to the plant during the summer months (plant records indicated average flows of 3.9 mgd in January 1971 and of 4.8 mgd in July 1971). During the 1971 survey the hydraulic load averaged 5.2 mgd, exceeding the plant capacity.

Currently being proposed is a regional treatment plant designed to serve the communities of Littleton and Englewood.[2/] Though only in the discussion stage, the proposal calls for the continued operation of the existing Littleton plant (4.5 mgd capacity) plus re-activation of the original Littleton facility (one mgd). Flows in excess of these 5.5 mgd would be diverted to the Englewood municipal facility, which is currently being expanded to handle a flow of 12 mgd. (All future expansions would be carried out at the site of the Englewood municipal treatment plant.)

Maintenance of adequate dissolved oxygen concentrations in the South Platte River, i.e. 6.0 mg/l,[*] at low flow conditions requires that the effluent contain no more than 25 mg/l BOD (based on assumed flow rate of 25 cfs).

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[*] This is the State of Colorado dissolved oxygen criterion for a cold water fishery.

TABLE 1

BACTERIOLOGICAL RESULTS
LITTLETON WASTEWATER TREATMENT PLANT

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/l
September 21, 1971	0800	5,100	40	>1.0
	1120	52,000	90	0.9
	1450	15,000	120	0.9
September 22, 1971	0900	38,000	230	1.2
	1245	17,000	280	1.1
	2045	100,000	2,600	1.0
September 23, 1971	0603	170	10	
	1500	1,900	<10	

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
LITTLETON WASTEWATER TREATMENT FACILITY
SEPTEMBER 21-25, 1971

Parameter[a/]	Influent		Effluent Before Chlorination		Effluent After Chlorination[b/]		Removal Efficiency before Cl_2	Removal Efficiency after Cl_2
	Range	Average	Range	Average	Range	Average		
Flow (mgd)					4.75-5.63	5.24		
pH (S.U.)	7.15-7.6		7.5-8.0		7.3-7.6			
Temperature (°C)	15-19		17-20		14-19			
Conductivity (μmhos/cm)	950-1,800		1,000-1,600		700-1,500			
BOD (mg/1)	150-170	158	30-40	33	30-40	35	73-82	75-80
TOC (mg/1)	80-210	118	20-60	40	30-50	40	33-75	44-67
Total Solids (mg/1)	830-1,000	885	590-690	650	700-710	705		
Suspended Solids (mg/1)	140-710	353	40		50			64
Settleable Solids (ml/1)	5[c/]							
NH_3 (mg/1)	10-13	12	9.5-12	10.5	11-12	11.5		
K_j-N (mg/1)	17-24	20	14-16	15	15-17	16		
NO_2-NO_3 (mg/1)	0.30-0.60	0.42	0.28-0.68	0.45	0.27-7.2	0.50		
Total P (mg/1)	6.4-9.6	8.0	6.0-7.6	6.9	6.4-7.8	7.1		

[a/] Analyses of BOD, TOC, total solids, suspended solids, and settleable solids were performed on composite samples.
[b/] This sampling was by plant personnel.
[c/] This is a single sample.

D. SUMMARY AND CONCLUSIONS

1. The efficiency of BOD removal was less than the present minimum value of 80 percent, as required by the State of Colorado. The weak strength of the influent (158 mg/l) was attributed to infiltration flows which continue to be a problem at this plant during the summer months.

2. Disinfection was adequate since fecal coliform bacteria levels were reduced to less than 1,000/100 ml, with one exception.

3. The hydraulic capacity of the municipal plant was exceeded during the time of the survey. Flows during the winter months of 1971 approached design capacity. Plant records indicated that 1971 summer flows exceeded the hydraulic capacity.

4. General plant maintenance appeared adequate. Routine laboratory analyses are performed, with complete records being maintained at the plant.

E. RECOMMENDATIONS

It is recommended that:

1. The biochemcial oxygen demand and suspended solids in the discharge each not exceed 25 mg/l, or 1,140 lb/day (at 5.5 mgd), whichever is less.

2. The effluent contain no more than 1,000 fecal coliform bacteria/100 ml.

F. REFERENCES

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin*, U. S. Department of Health, Education, and Welfare, Public Health Service. Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado. December, 1965, Appendix B.

2/ *Littleton and Englewood Look at Joint Sewer Plant*, Littleton, (Colorado) Independent, No. 45, May 25, 1972.

LONGMONT WASTEWATER TREATMENT PLANT
LONGMONT, COLORADO

A. INTRODUCTION

The Longmont wastewater treatment facility, which is located on the St. Vrain Creek (RM 270.0/22.3), serves a population of 23,000 people. The plant is manned 16 hours/day by a superintendent, three operators and one part-time laboratory technician. From August through December, wastewater (1.3 mgd) is also received from Longmont Turkey Processors, Inc.

In 1964[1/] the plant, which consists of a high-rate trickling filter designed for 4.0 mgd, was not providing adequate treatment or disinfection. Interconnections between the sanitary sewers, sub-drains and storm sewers permitted the entry of ground water and storm water into the sanitary sewers. Domestic sewage was being discharged into St. Vrain Creek through a storm drain.

An in-plant survey was conducted at the Longmont wastewater treatment plant from January 31 to February 3, 1972. City Manager Gerald Trotter, and Clark Coe, plant superintendent, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The treatment facility has a design capacity of 5.24 mgd, with pumping capacity being the limiting factor. The facility consists of a high-rate trickling filter plant (constructed in 1960) and an activated biofilter (ABF) plant (constructed since 1966). This ABF plant can also be operated as a high-rate trickling filter plant [Figure 1]. At the time of the 1972

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survey, the ABF plant was operating in the trickling filter mode. The raw influent passes through preliminary treatment facilities, consisting of an automatic bar screen and comminutor, and divides between the two plants (57 percent is diverted to the trickling filter plant). The principal components of the trickling filter plant are:

1. Primary treatment -- clarifier (85 ft in diameter and 8 ft deep);
2. Secondary treatment -- trickling filter (with 17,000 cu ft rock media) and a clarifier (80 ft in diameter and 8 ft deep); and
3. Disinfection -- chlorine is added in the final clarifier, although not in operation during the 1972 survey.

The principal components of the ABF plant are:

1. Primary treatment -- clarifier (70 ft in diameter and 7.5 ft deep);
2. Secondary treatment -- ABF (with 17,000 cu ft of redwood as a filter medium) and a clarifier (95 ft in diameter and 7.7 ft deep); and
3. Disinfection -- chlorine is added in the filter clarifier, although not in operation during the survey.

The sludge generated in both plants is pumped first to a degritter and then to a thickener (designed for a capacity of 0.6 mgd). The thickened sludge is pumped either to a two-stage digester (with a volume of 20,000 ft^3/digester) or to a centrifuge. Solids are then trucked to the city dump.

An artesian well located on the plant site, near the headworks, discharges water into the outfall line. The effluent from the trickling

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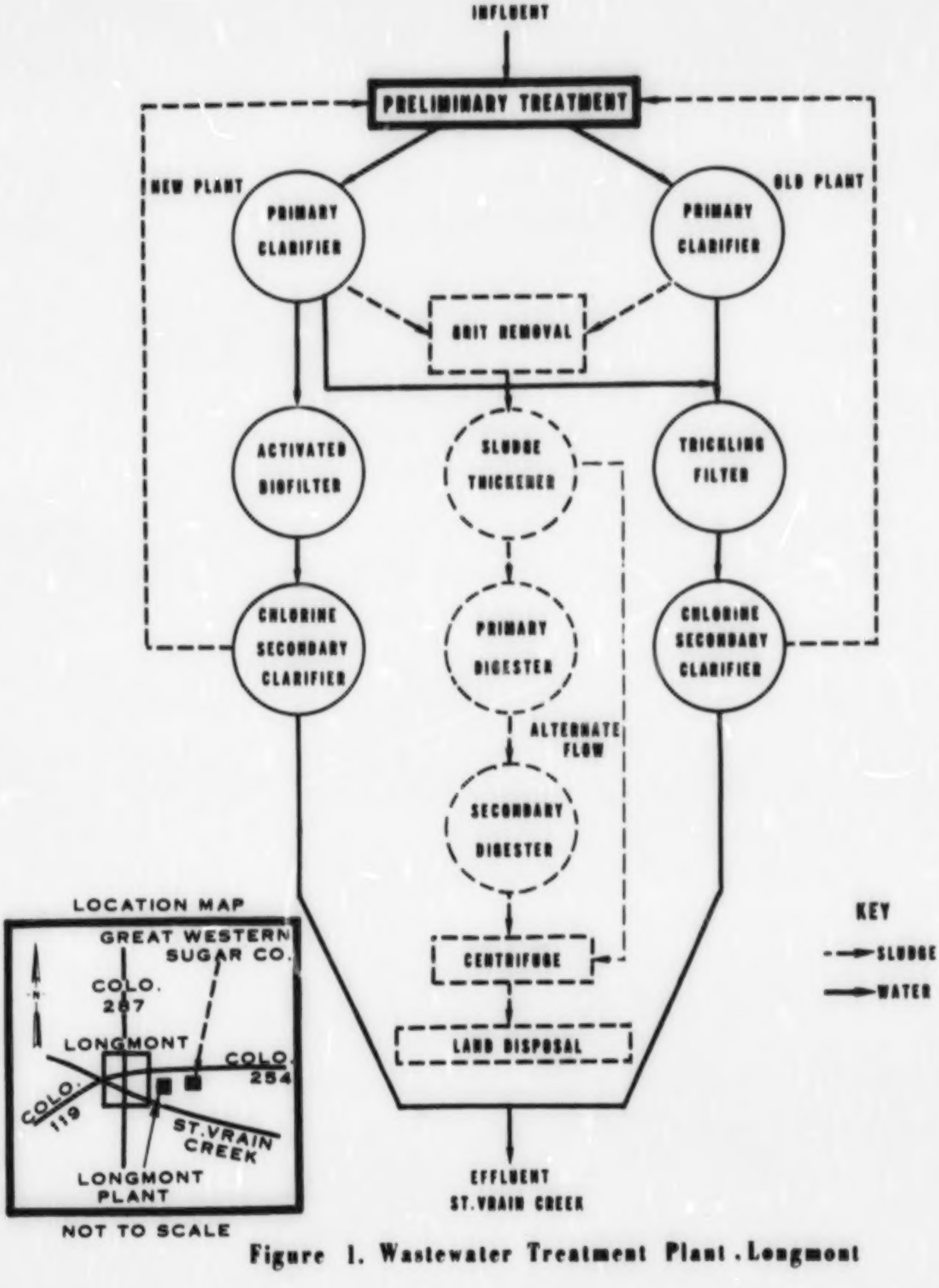
INFLUENT
PRELIMINARY TREATMENT
NEW PLANT
OLD PLANT
PRIMARY CLARIFIER
PRIMARY CLARIFIER
GRIT REMOVAL
ACTIVATED BIOFILTER
SLUDGE THICKENER
TRICKLING FILTER
CHLORINE SECONDARY CLARIFIER
PRIMARY DIGESTER
CHLORINE SECONDARY CLARIFIER
ALTERNATE FLOW
SECONDARY DIGESTER
CENTRIFUGE
LAND DISPOSAL
EFFLUENT
ST. VRAIN CREEK
KEY
SLUDGE
WATER
LOCATION MAP
GREAT WESTERN SUGAR CO.
N
COLO. 287
LONGMONT
COLO. 254
COLO. 119
ST. VRAIN CREEK
LONGMONT PLANT
NOT TO SCALE

Figure 1. Wastewater Treatment Plant, Longmont

filter and ABF plants mixes with the well water, and the combined waste flow is discharged to St. Vrain Creek.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composites of the combined influent and effluent and two 24-hour composites of the artesian-well discharge were collected using SERCO automatic samplers. Influent and effluent samples were composited on a flow weighted basis from readings obtained at the headworks. The artesian well flow was gaged; and composites were made of equal portions of the hourly samples. Temperature, pH, and conductivity were measured periodically at the three sampling stations. Grab samples of the combined effluent were collected for bacteriological analysis. Chlorine residual measurements were not made as the chlorination facilities were not in operation during the survey.

During the survey, the following observations were made:

1. Raw sludge was centrifuged and hauled, in an open dump truck, to the city dump. On two occasions, sludge was observed being spilled, on turns or sudden stops. The sludge was not being buried at the dump; rather, the material was dumped in such a manner that there was a potential for pollution of St. Vrain Creek. Fred Matter, Assistant Director of the Water Pollution Control Division, Colorado State Department of Health, was notified of this procedure.

2. Effluent from the primary clarifier in the trickling filter plant flowed through a rectangular open channel located so that during peak flow excess wastewater spilled over one side of the channel and mixed with the artesian well water. This condition was observed each time the

influent flow rate exceeded 5.5 mgd (approximate pumping capacity).

3. The ABF plant was being operated as a high-rate trickling filter at the time of the survey. This mode of operation was necessary because of inadequate sludge recycle pumping capacity.

4. Laboratory facilities were provided for the performance of chemical tests of sewage quality. Tests performed include BOD, suspended solids, settleable solids, chlorine residual, pH, volatile acid, and alkalinity. These tests are run daily, five days per week.

5. Adequate routine maintenance was being provided.

The survey data [Table 1] indicate that the overall BOD removal efficiency* ranged from 45 to 86 percent and averaged 63 percent. This was in violation of State requirements (i.e., a minimum of 80 percent BOD removal). The average BOD was 57 mg/l after dilution by well water (1,770 lb BOD/day are discharged to St. Vrain Creek). At the point of discharge the effluent was essentially the entire flow of the creek (RM 22.3 to RM 22.0) as the flow in St. Vrain Creek was diverted just upstream by the Great Western Sugar Company.

Chlorination facilities were not in operation during the survey because of equipment malfunction (i.e., chlorinator froze). Densities of fecal coliform bacteria ranged from 470,000 to 1,200,000/100 ml [Table 2].

A stream survey, conducted in September 1971, revealed that the discharge from the Longmont plant caused water quality degradation in

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* The overall BOD efficiency was calculated by subtracting the load contributed by the artesian well water.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
LONGMONT WASTEWATER TREATMENT FACILITY
JANUARY 31-FEBRUARY 2, 1972

Parameter[a]	Influent		Combined Effluent[b]		Artesian Well Water		Percent[c]
	Range	Average	Range	Average	Range	Average	Removal
Flow (mgd)	2.75-3.17	2.95	3.40-4.10	3.72	0.60-0.94	0.783	
pH (S.U.)	7.0-7.8		7.1-7.3		7.0-7.3		
Temperature (°C)	8.0-11.0		4.5-10.0		4.0-8.5		
Conductivity (µmhos/cm)	825-1,400		1,000-2,000		1,150-1,800		
BOD (mg/l)	172-218	188	20-78	57	2.4-5.6	3.5	
COD (mg/l)	324-834	576	143-371	261	35-44	39	42-48
Total Solids (mg/l)	811-1,080	925	781-1,540	1,050	1,190-1,360	1,280	0-31
Suspended Solids (mg/l)	154-372	229	36-104	65	1-9	6	13-83

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[a] Analyses of BOD, COD, total solids, and suspended solids were performed on composite samples.

[b] Combined effluent includes the effluents from the trickling filter and ABF plant and the artesian well water.

[c] Removal efficiencies were calculated by subtracting the load contributed by the artesian well water from the combined effluent.

TABLE 2

BACTERIOLOGICAL RESULTS
LONGMONT WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml
January 31, 1972	1015	7,900,000	1,100,000
	1330	8,000,000	1,200,000
February 1, 1972	1000	11,000,000	830,000
	1300	10,000,000	870,000
February 2, 1972	0920	8,300,000	470,000
	1115	6,600,000	780,000

St. Vrain Creek (e.g. increased fecal coliform bacteria levels; bottom deposits). A subsequent stream survey, in December 1971, showed that the discharges from the Longmont plant and from the Great Western Sugar Company mill were detrimental to the receiving water. Dissolved oxygen values were less than 4 mg/l at all times and fell below 3 mg/l 50 percent of the time. Fecal coliform bacteria densities increased; *Sphaerotilus*, a filamentous bacterium, covered the stream bottom; and organic solids formed large sludge beds in the creek. The intensity of the pollution was sufficient to eliminate virtually all intolerant benthos (mayflies and caddisflies) and to greatly reduce the numbers of tolerant sludgeworms and bloodworms.

In order to eliminate the above conditions, the Longmont municipal treatment plant discharge must contain no more than 20 mg/l each of biochemical oxygen demand and suspended solids. Requirements for the Great Western mill are discussed in the report, "Technical Appendix on Industrial Waste-Source Evaluations."[2/]

D. SUMMARY AND CONCLUSIONS

1. The Longmont wastewater treatment facilities were not providing adequate treatment. Average efficiency of BOD removal was less than the 80 percent level required by the State.

2. Disinfection of the effluent was not being provided owing to equipment malfunction.

3. The ABF plant was operating as a high-rate trickling filter because of operational problems with the filter.

4. The effluent from the facility was essentially the entire flow in St. Vrain Creek because of an upstream diversion.

5. The design capacity of the facility is limited by pumping capacity. At peak flows, primary clarifier effluent overflows into the outfall line.

E. RECOMMENDATIONS

It is recommended that:

1. The biochemical oxygen demand and suspended solids in the effluent not exceed 20 mg/l or 850 lb/day of each, whichever is less.

2. Disinfection of the effluent be provided at all times.

3. Pumping capacity of the plant be increased to prevent primary treated sewage from overflowing the channel into the outfall line to St. Vrain Creek.

F. REFERENCES

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

2/ *Technical Appendix on Industrial Waste-Source Evaluations, Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72*, Environmental Protection Agency, National Field Investigations Center-Denver and Region VIII, Denver, Colorado, June. 1972.

LOVELAND WASTEWATER TREATMENT PLANT
LOVELAND, COLORADO

A. INTRODUCTION

The Loveland wastewater treatment facility, located on the Big Thompson River (RM 260.4/24.5), serves an estimated 17,000 persons, plus Hewlett-Packard electronic plant with an undetermined amount of industrial wastes. The plant is manned eight hours/day, five days/week by two operators and, during the summertime, by one parttime helper. The capitol cost of the plant in 1962 was $600,000; in 1971 the operation budget was $68,700.

This plant was evaluated in March 1966 and January 1967 as part of the South Platte River Basin Project studies.[1/] At that time, the average daily flow was 1.8 mgd or approximately 130 gallons per capita. Adequate disinfection was not provided. The BOD and suspended solids removal efficiencies ranged from 76 to 83 percent and 73 to 87 percent, respectively.

Personnel of the National Field Investigations Center-Denver conducted an in-plant survey from January 31 to February 3, 1972, in order to determine the effectiveness of waste treatment practices and the waste loads discharged to the Big Thompson River. Mr. Dallemand, Director of Public Works, was contacted for assistance and information.

B. WASTE TREATMENT FACILITIES

This plant is designed for an average flow of 3.0 mgd with a capacity for 6.0 mgd at peak flow. Minimum flows are about 1.8 mgd. The principal components of the plant [Figure 1] are:

1. Preliminary treatment -- bar screen, grit chamber, and comminutor;
2. Primary treatment -- two clarifiers (78 ft. in diameter and 7.75 ft side water depth (SWD); two-hour detention time at an overflow rate of 800 gal/ft^2/day;
3. Secondary treatment -- two high-rate trickling filters (each 98 ft in diameter, 6 ft 3 in depth) designed for a BOD loading of 75 lb/1,000 ft^3 and a hydraulic loading of 22 million gal/acre/day; one clarifier (rectangular with dimensions 41 ft by 92 ft by 9 ft SWD), detention time of two hours at an overflow rate of 800 gal/ft^2/day;
4. Disinfection -- chlorine added to secondary clarifier; and
5. Digestion -- two-stage anaerobic digester (primary digester 35 ft in diameter, 20 ft SWD, unit loading 0.2 lb/ft^3, gas recirculation); secondary digester same size as primary (no gas recirculation). Digested sludge is removed to drying beds designed for 1.25 ft^2/capita (14 beds each 20 ft by 75 ft).

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Influent and effluent sampling (three 24-hr composites) was conducted using SERCO automatic samplers during the period January 31 through February 2, 1972. Samples were composited on a flow weighted basis from readings taken at the headworks. Periodic measurements were made of temperature, pH, and conductivity. Grab samples of the effluent were also collected periodically for bacteriological analyses and for chlorine residual measurements.

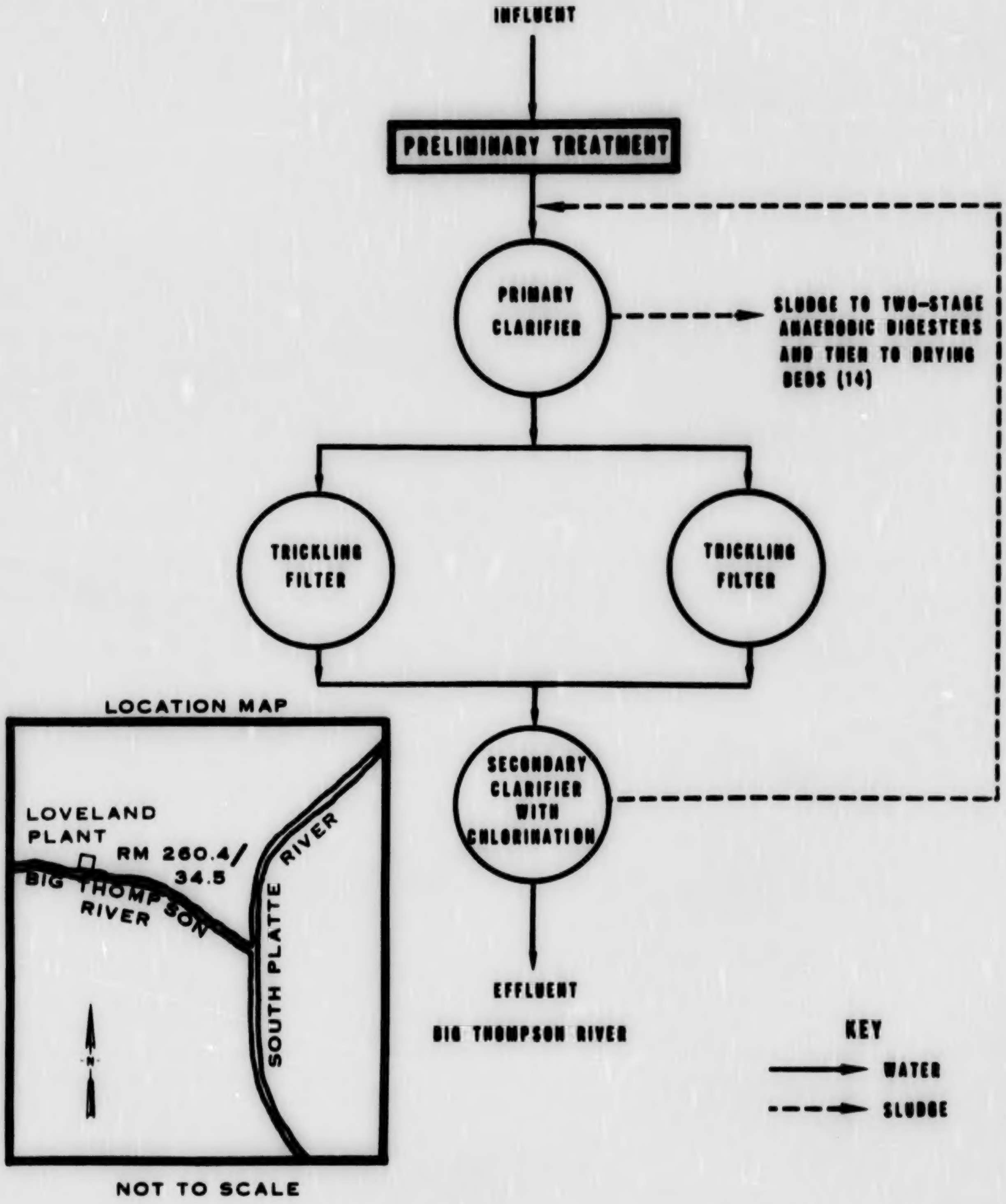
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS (14)
TRICKLING FILTER
TRICKLING FILTER
SECONDARY CLARIFIER WITH CHLORINATION
EFFLUENT
BIG THOMPSON RIVER
KEY
WATER
SLUDGE
LOCATION MAP
LOVELAND PLANT
RM 260.4/34.5
BIG THOMPSON RIVER
SOUTH PLATTE RIVER
N
NOT TO SCALE

Figure 1. Wastewater Treatment Plant, Loveland

A review of the survey data [Table 1] shows that the BOD removal efficiency ranged from 59 to 71 percent which is in violation of State requirements. However, the plant was not hydraulically or organically overloaded.

Chlorine residual values [Table 2] ranged from 0.3 to 0.8 mg/1 less than the minimum required by the State of Colorado (i.e., 1 mg/1 after 15 minutes detention). The fecal coliform bacteria densities ranged from <100 to 22,000/100 ml.

Stream surveys in September and December 1971[2/] revealed that the discharge from the Loveland wastewater treatment plant degraded the water quality and the stream bed environment of the Big Thompson River.

Inorder to maintain water quality in the Big Thompson River during low flow conditions (assumed to be 25 cfs), the effluent must contain no more than 25 mg/1 each of BOD and suspended solids.

Laboratory facilities have been provided at the Loveland wastewater treatment plant for the performance of chemical tests of sewage quality. Chlorine residual, BOD, pH, suspended solids, volatile acids and alkalinity are analyzed weekly. Records are maintained on all analysis that are performed.

D. SUMMARY AND CONCLUSIONS

1. The BOD removal efficiency did not meet the Colorado requirements for secondary treatment because of plant operational problems.

2. Adequate disinfection of the effluent was not being provided.

3. The discharge from this plant results in water quality degradation of the Big Thompson River.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
LOVELAND WASTEWATER TREATMENT FACILITY
JANUARY 31-FEBRUARY 3, 1972

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			2.62-2.83	2.73	
pH (S.U.)	6.8-9.75		6.9-8.1		
Temperature (°C)	8-11.5		6.0-10.0		
Conductivity (μmhos/cm)	800-1,100		950-1,100		
BOD (mg/l)	148-210	174	60-66	62	59-71
COD (mg/l)	512-921	680	245-301	264	50-73
Total Solids (mg/l)	839-1,050	933	671-692	679	20-36
Suspended Solids (mg/l)	232-318	260	46-64	53	79-80

---

[a] Analyses of BOD, COD, total solids, and suspended solids are performed on composite samples.

TABLE 2

BACTERIOLOGICAL RESULTS
LOVELAND WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
January 31, 1972	0810	<100	<100	0.8
	1415	2,300,000	22,000	0.8
February 1, 1972	1220	>80,000	21,000	0.4
	1450	>80,000	20,000	0.6
February 2, 1972	1225	150,000	400	
	1505	630,000	6,600	0.3

E. RECOMMENDATIONS

It is recommended that:

1. The biochemical oxygen demand and suspended solids in the plant effluent each not exceed 25 mg/l or 650 lb/day (based on present design), whichever is less, inorder to prevent degradation in water quality of the Big Thompson River.

2. Disinfection of the plant effluent be accomplished in accordance with the Colorado requirements.

F. REFERENCES

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin*, PR-3, U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965. Appendix B.

2/ *Water Quality Investigations in the South Platte River Basin, Colorado, 1971-72*, National Field Investigations Center-Denver and Region VIII, Denver, Colorado, April 1972.

LYONS WASTEWATER TREATMENT PLANT
LYONS, COLORADO

A. INTRODUCTION

The Lyons treatment plant serves a population of approximately 1,000 people and is staffed by one part-time operator. Constructed in 1957, the original plant consisted of a clarigester. An aerated lagoon was added in 1969.

An in-plant evaluation in 1964[1/] showed that 65,000 gpd received inadequate treatment in this primary plant. Additional treatment facilities, including disinfection and improved operation, were recommended.

An in-plant survey was conducted during the period September 27-29, 1971. William Brackett, Plant Operator, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The principal components of the system [Figure 1] are:

1. Primary treatment -- clarigester (24 ft in diameter and 18 ft deep);
2. Secondary treatment -- aerated lagoon (surface area of approximately one acre) employing one 3-hp mechanical aerator;
3. Disinfection -- chlorine contact chamber (7 ft in diameter and 11 ft deep) with a detention time of 90 minutes, at present flow of 0.05 mgd. (There was not any information available regarding design capacity.); and
4. Sludge disposal -- from clarigester to aerated lagoon.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Grab samples of the effluent (before and after chlorination) were collected daily on September 28 and September 29, 1971. Bacteria counts and chlorine residuals were determined on the samples collected after chlorination. Temperature, pH, and conductivity were measured each time a sample was collected.

The chlorination facilities were inoperative on September 27 and 28, 1971, due to failure of an electrical pump. The pump was replaced, and chlorination initiated September 29. Disinfection was adequate on this date [Table 1].

The survey data [Table 2] show that the effluent from the Lyons wastewater treatment facility contained 20 mg/l of BOD, a loading of eight pounds per day to the St. Vrain Creek. The ten-year, seven-day low flow for St. Vrain Creek is 0.8 cfs. At this plant contribution, the BOD of the stream would increase about 2 mg/l at low flow.

D. SUMMARY AND CONCLUSIONS

1. Loadings of BOD and suspended solids from the Lyons plant are minimal and will not cause any adverse effect upon St. Vrain Creek.

2. Chlorination facilities were out of service because of pump failure two of the three days of the survey.

E. RECOMMENDATIONS

It is recommended that the necessary auxilary equipment be installed to preclude shutdown of the chlorination facilities.

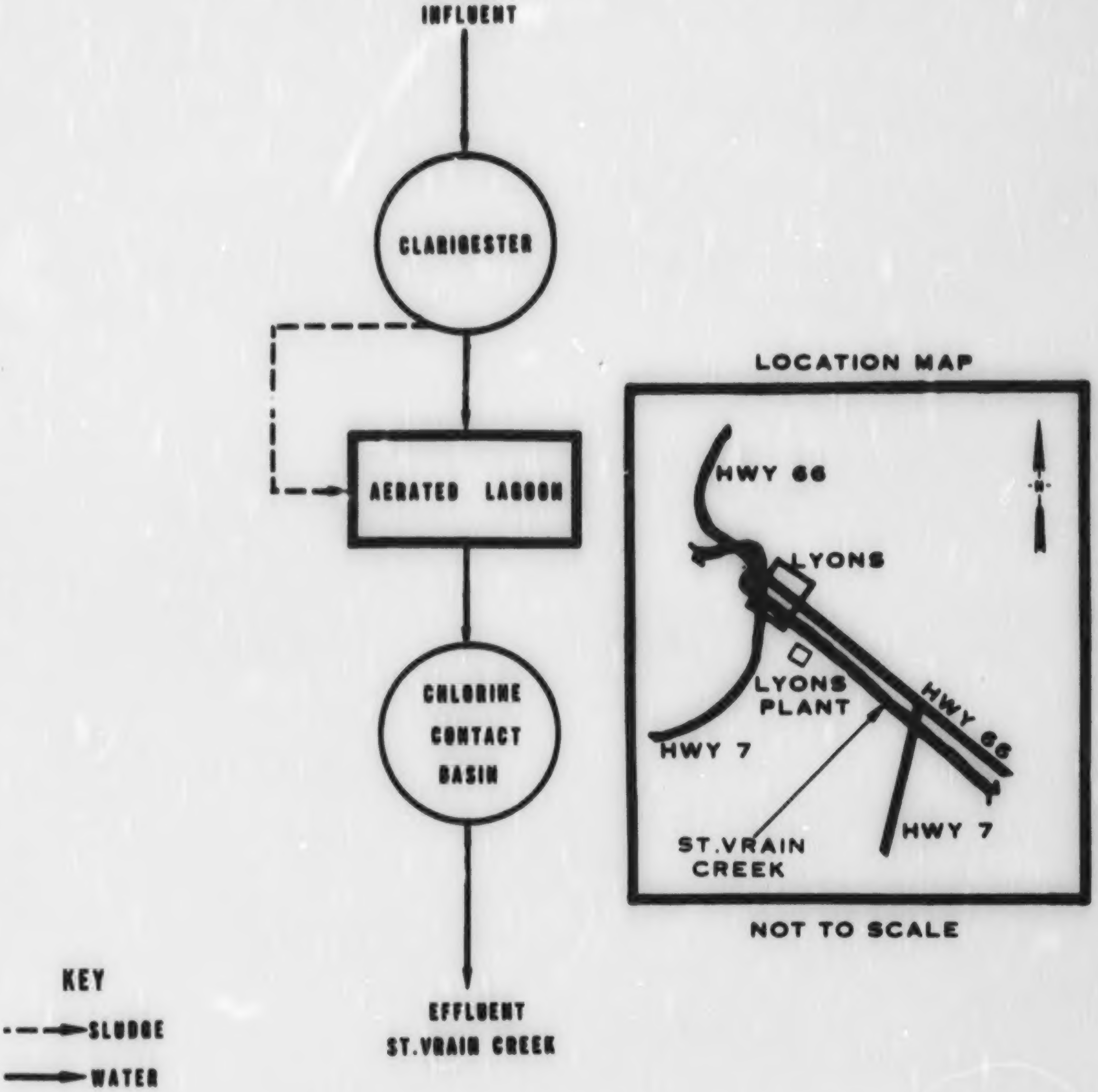
INFLUENT
CLARIGESTER
AERATED LAGOON
CHLORINE CONTACT BASIN
EFFLUENT
ST.VRAIN CREEK
KEY
SLUDGE
WATER
LOCATION MAP
HWY 66
LYONS
LYONS PLANT
HWY 66
HWY 7
HWY 7
ST.VRAIN CREEK
N
NOT TO SCALE

Figure 1. Wastewater Treatment Plant . Lyons

TABLE 1

BACTERIOLOGICAL RESULTS
LYONS WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Cl_2 Residual mg/1
September 27, 1971	1230	490,000	13,000	0.0
September 28, 1971	0915	500,000	55,000	0.0
	1500	>80,000	18,000	0.0
September 29, 1971[a]	0900	>8,000	870	1.7
	1305	>8,000	730	1.3

---

a/ The effluent was being chlorinated on this date.

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
LYONS WASTEWATER TEEATMENT FACILITY
SEPTEMBER 27-29, 1971

Parameter	Effluent	
	Range	Average
Flow (mgd)	0.05[a/]	
pH (S.U.)	6.8-7.6	7.2
Temperature (°C)	14-16	15
Conductivity (μmhos/cm)	200-250	225
BOD (mg/l)		20[a/]
Total Solids (mg/l)	200-1,850	1,030
Suspended Solids (mg/l)	50-80	65
TOC (mg/l)	30-40	35
Total N (mg/l)	7.8-8.0	7.9
NH_3 (mg/l)		3[a/]
$NO_2 + NO_3$ (mg/l)	0.17-0.16	0.16
Total P (mg/l)	3.4-3.6	3.5

[a/] All values are the same.

F. REFERENCE

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

SOUTH ADAMS WATER AND SANITATION DISTRICT
WASTEWATER TREATMENT PLANT
9699 McKAY AVENUE
DERBY, COLORADO

A. INTRODUCTION

The South Adams Water and Sanitation District plant, located on the South Platte River (RM 306.7), serves approximately 19,500 people. The plant, staffed with a chief operator (Class A) and two plant operators (Class B), is manned 14 hours/day, seven days/week. Original construction of the plant was carried out in 1957; there have been no major revisions since then.

This plant was evaluated during the South Platte River Basin Project studies.[1/] At that time it served 16,000 people and was providing adequate treatment (91 percent BOD removal). Laboratory tests included pH and residual chlorine on a daily basis; and on a weekly one, suspended solids and volatile acids. Records of flow, gas production, and digested sludge were prepared daily by the chief operator. Additional tests such as the BOD of influent and effluent were recommended.

Between January 31 and February 4, 1972, an in-plant survey was conducted by personnel of the National Field Investigations Center-Denver to ascertain waste treatment practices and waste loads discharged. Ray Duggans, Chief Operator, provided assistance and information.

B. WASTE TREATMENT FACILITIES

The plant is designed for a capacity of 2.5 mgd. Principal components [Figure 1] of the system are as follows:

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1. Preliminary treatment -- grit chamber, bar screen, and comminutor;
2. Primary treatment -- clarifier (100 ft in diameter and 7 ft side water depth (SWD));
3. Secondary treatment -- one high-rate trickling filter (140 ft in diameter, 6 ft rock depth), one clarifier (100 ft in diameter, 7 ft SWD);
4. Disinfection -- chlorine contact chamber (baffled), detention time of 15 minutes at 2.5 mgd; and
5. Digestion -- two-stage (primary digester, 45 ft in diameter by 37.5 ft, secondary digester, same size as primary unit), digested sludge is placed in drying beds (five at 175 ft by 45 ft each).

Plant operators provide adequate routine maintenance. Laboratory facilities have been provided for the performance of chemical tests of sewage quality. The tests performed are limited to basic analyses (e.g., pH, chlorine residual, suspended solids, volatile acid). Records of plant operation reflect flow, gas production and digested sludge quality.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

A three-day sampling program commenced on January 31, 1972. Samples (three 24-hr composites) were collected of the influent and the effluent (before chlorination) using SERCO automatic samplers, which collect a sample portion each hour. These samples were then composited on a flow weighted basis from readings at the headworks. The samples were analyzed for BOD, COD, and solids [Table 1]. Temperature, pH, and conductivity were measured at all sampling locations. Periodic grab samples were

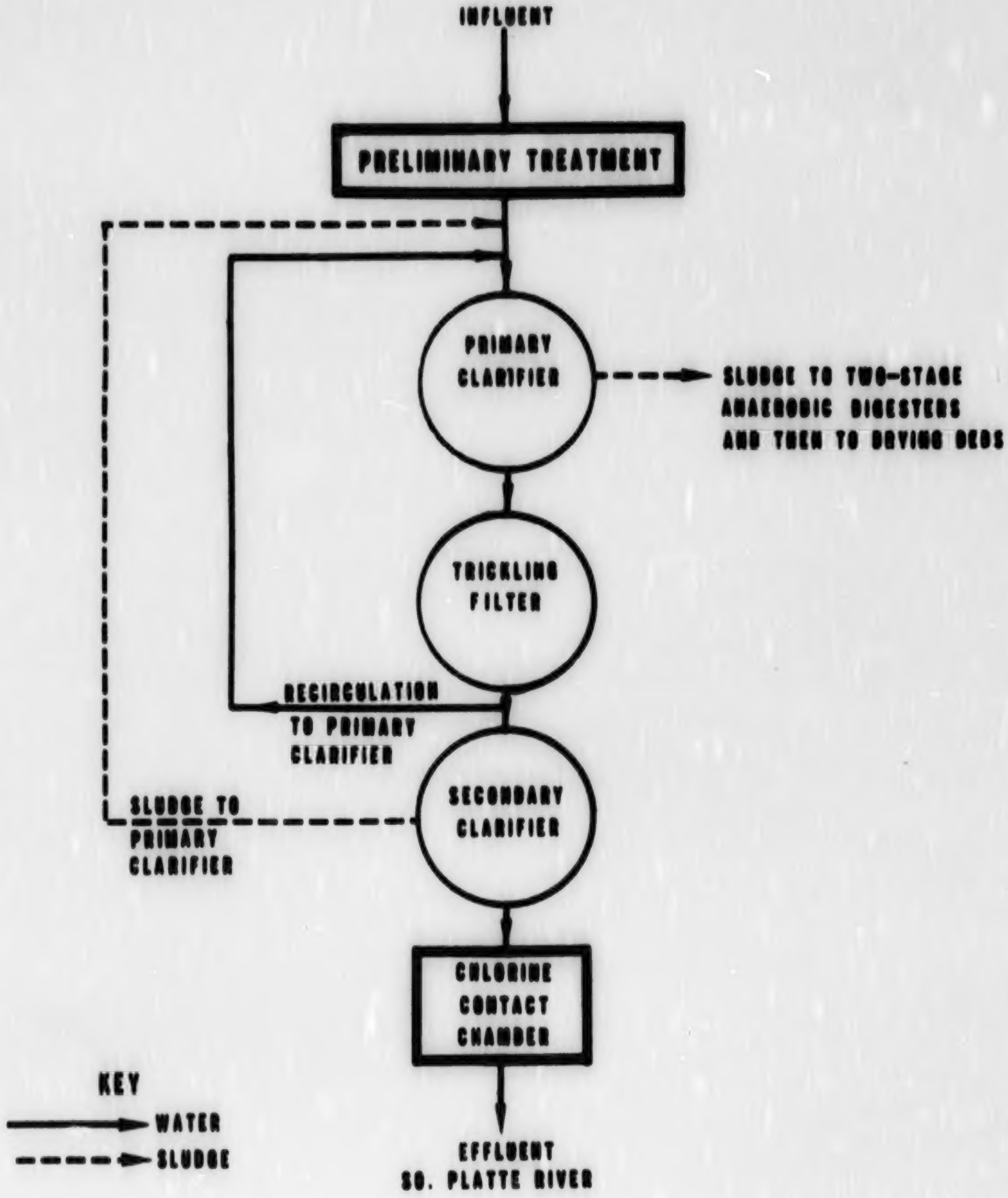
INFLUENT
PRELIMINARY TREATMENT
PRIMARY CLARIFIER
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTERS AND THEN TO DRYING BEDS
TRICKLING FILTER
RECIRCULATION TO PRIMARY CLARIFIER
SECONDARY CLARIFIER
SLUDGE TO PRIMARY CLARIFIER
CHLORINE CONTACT CHAMBER
KEY
WATER
SLUDGE
EFFLUENT SO. PLATTE RIVER

Figure 1. Wastewater Treatment Plant . South Adams Sanitation District

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
SOUTH ADAMS WASTEWATER TREATMENT FACILITY
JANUARY 31-FEBRUARY 3, 1972

Parameter[a/]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			1.8-1.9	1.8	
pH (S.U.)	7.0-7.7		7.3-7.7		
Temperature (°C)	8-12		6-13		
Conductivity (µmhos/cm)	1,300-3,200		1,500-2,000		
BOD (mg/1)	200-241	223	50-70	62	71-75
COD (mg/1)	450-789	579	205-274	239	47-65
Total Solids (mg/1)	1,190-1,620	1,380	1,110-1,190	1,160	0-27
Suspended Solids (mg/1)	89-400	236	48-298	145	0-78

[a/] Analyses of BOD, COD, total solids, and suspended solids were performed on composite samples.

collected for bacteriological analyses and measurements of chlorine residual [Table 2].

The BOD and suspended solids waste loads entering the plant at the time of this survey were slightly less than those observed during the 1964 survey. The BOD removal efficiency ranged from 71-75 percent, significantly less than that observed in 1964. Solids removal was also poor. High solids carry-over was noted from the final clarifier during the survey.

Disinfection was very effective as evidenced by the low bacterial densities [Table 2]; however, the high chlorine residuals observed indicate an excessive amount of chlorine was used. Residuals as high as 4.0 mg/l were measured.

D. SUMMARY AND CONCLUSIONS

Although the South Adams plant was not hydraulically or organically overloaded, it did not provide adequate BOD and suspended solids removal. The low removal efficiencies were attributed to the high carry-over of suspended solids in the effluent.

Disinfection was very effective but an excessive amount of chlorine was applied during the survey. Detrimental effects can occur in the receiving stream at the high residuals observed.

E. RECOMMENDATIONS

It is recommended that:

1. The effluent from this plant contain not greater than 30 mg/l each of biochemical oxygen demand and suspended solids or the total load discharged daily not exceed 650 pounds of each at present design flow.

TABLE 2

BACTERIOLOGICAL RESULTS
SOUTH ADAMS WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/l
January 31, 1972	0735	<10	<10	1.5
	0900	20	<10	
	1420	4,000	30	0.5
February 1, 1972	0920	<4	4	4.0
	1345	<4	<4	2.0
February 2, 1972	0800	30	8	3.0
	0900	100	<10	1.2

2. The chlorine application rate be controlled to produce a residual of 1.0 mg/l after 15 minutes detention at peak hourly flow and at no time shall the fecal coliform bacterial density exceed 1,000/100 ml.

F. REFERENCE

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin*, U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965, Appendix B.

SOUTH LAKEWOOD SANITATION DISTRICT
WASTEWATER TREATMENT PLANT
700 DEPEW
LAKEWOOD, COLORADO

A. INTRODUCTION

The South Lakewood Sanitation District Wastewater Treatment Plant serves a population of approximately 15,000. The contact stabilization process is used, with the effluent being discharged to the South Platte River (RM 318.9).

The plant is staffed by the district superintendent and one operator and is manned eight hours/day, seven days/week. The annual operating budget is $48,000.

A survey in 1964[1/] indicated that the plant served 6,500 persons and was staffed with one operator. The investigation concluded that the plant was not providing adequate treatment and that laboratory control was not maintained to provide efficient daily operation of the facility.

A 1971 in-plant survey was conducted from August 17 through 20. John Kruz, district superintendent, provided assistance and information.

B. WASTEWATER TREATMENT FACILITIES

The plant [Figure 1] is designed for a capacity of 1.2 mgd and an organic loading of 4,880 pounds BOD per day. Principal components of the system are:

1. Preliminary treatment -- bar screen and grit chamber;
2. Secondary treatment -- contact stabilization system (one contact tank and two stabilization or reaeration tanks), five

clarifiers (four rectangular, approximately 60 ft x 20 ft x 9 ft and one circular, 50 ft in diameter) and a polishing pond;

3. Disinfection -- chlorine added to polishing pond influent and effluent with the two-mile-long outflow line to the South Platte River providing contact time, and
4. Sludge handling -- aerobic digestion, with sludge disposal to land.

An EPA grant offer has been made and a contract awarded for expansion of the plant from a design capacity of 1.2 to 1.8 mgd. This expansion includes a sixth clarifier, a new grit chamber, and sludge handling equipment.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hour composites of the influent and effluent (after chlorination) were collected using SERCO automatic samplers. The effluent samples were collected at a manhole located approximately 50 yd from the South Platte River. Samples were composited on a flow weighted basis from measurements taken at the headworks. Periodic measurements were made for pH, temperature, and conductivity. Grab samples were also collected of the effluent (after chlorination) for bacteriological analyses and for chlorine residual measurements.

A review of the survey data [Table 1] revealed that the South Lakewood plant was discharging to the South Platte River, a waste load of 483 pounds of BOD and 890 pounds of suspended solids. The BOD removal efficiency was less than the 80 percent minimum required by the State. The flow averaged 1.8 mgd. The expanded treatment facilities are designed for this flow which does not allow for any future increase in flow.

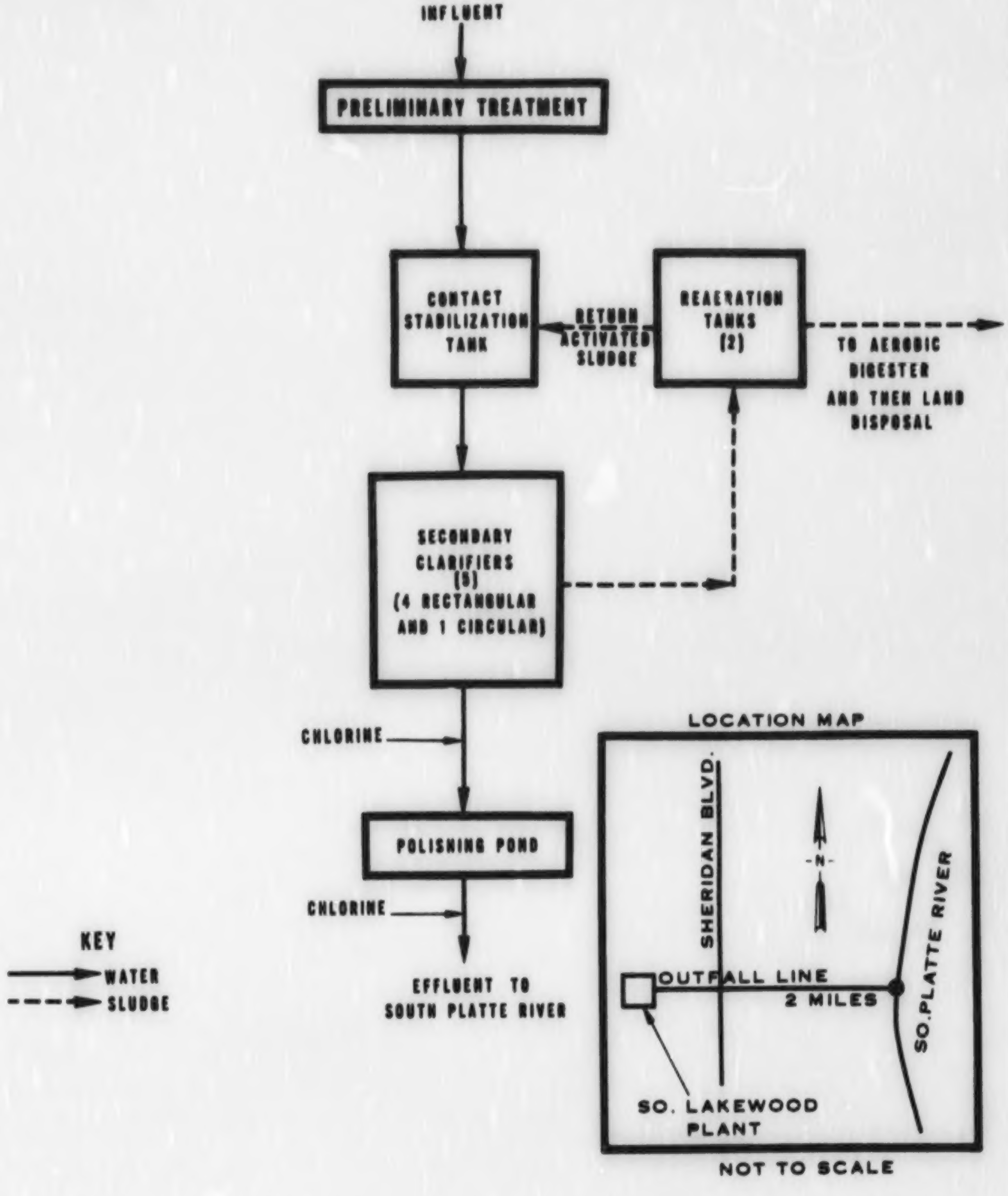
INFLUENT
PRELIMINARY TREATMENT
CONTACT STABILIZATION TANK
RETURN ACTIVATED SLUDGE
REAERATION TANKS (2)
TO AEROBIC DIGESTER AND THEN LAND DISPOSAL
SECONDARY CLARIFIERS (5) (4 RECTANGULAR AND 1 CIRCULAR)
CHLORINE
POLISHING POND
CHLORINE
EFFLUENT TO SOUTH PLATTE RIVER
KEY
WATER
SLUDGE
LOCATION MAP
SHERIDAN BLVD.
-N-
SO. PLATTE RIVER
OUTFALL LINE
2 MILES
SO. LAKEWOOD PLANT
NOT TO SCALE

Figure 1. Wastewater Treatment Plant, South Lakewood Sanitation District
]

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
SOUTH LAKEWOOD WASTEWATER TREATMENT FACILITY
AUGUST 17-20, 1971

Parameter[a]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			1.7–1.8	1.8	
pH (S.U.)	6.4–8.4		6.7–8.6		
Temperature (°C)	18–22		17–22		
Conductivity (μmhos/cm)	850–950		900–1,000		
BOD (mg/1)	100–110	103	13–60	33	45–87
TOC (mg/1)	81–161	122	21–34	26	74–81
Total Solids (mg/1)	640–820	717	540–660	600	5–27
Suspended Solids (mg/1)	90–150	113	40–90	60	0–67

---

[a] Analyses of BOD, TOC, total solids, and suspended solids were performed on composite samples.

Chlorine residuals in the effluent varied from 0.05 to greater than 1.0 mg/l [Table 2]. Disinfection was generally adequate as evidenced by the fecal coliform bacteria densities. It would appear, however, that most of the time, an excessive amount of chlorine was being applied.

D. SUMMARY AND CONCLUSIONS

The South Lakewood plant did not provide adequate treatment of wastewater, (i.e., less than 80 percent BOD removal) as required by the State of Colorado. The plant is presently under expansion to a design capacity of 1.8 mgd; this flow value was observed at the time of the survey.

E. RECOMMENDATIONS

It is recommended that:

1. The operation of this plant be discontinued and all wastewater be diverted to the Metropolitan Denver Sewage Disposal system.

2. In the interim, treatment practices provide an effluent that contains no more than 30 mg/l each of biochemical oxygen demand and suspended solids, or 450 lb/day, whichever is less.

F. REFERENCE

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin*, PR-3, U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965. Appendix B.

TABLE 2

BACTERIOLOGICAL RESULTS
SOUTH LAKEWOOD WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
August 17, 1971	0920	1,200	<4	>1.0
	1220	56	<4	>1.0
	1410	340,000	48,000	<1.0
August 18, 1971	1400	>80,000	>6,000	0.05
	1940	180	29	>1.0
August 19, 1971	0810	30	<4	1.0
	1105	1,600	440	0.60
	1545	7,900	700	>1.0

STERLING WASTEWATER TREATMENT PLANT
STERLING, COLORADO

A. INTRODUCTION

The Sterling wastewater treatment facility is located on the South Platte River (RM 148.6). This high-rate trickling filter plant, constructed in 1961 and expanded in 1966, presently serves a population of approximately 11,000 people. The plant is manned eight hours/day six days/week by three operators and a superintendent. Wastewater (0.49 mgd) from the Sterling Beef Packing Company is also treated by this municipal plant.

A survey, conducted in 1966,[1/] showed that a) more than 80 percent of the BOD loading was from the Sterling Beef Packing Company; b) the plant was organically overloaded; c) the BOD removal efficiency was less than 80 percent; and d) disinfection of the effluent was not being provided. As a result, pre-treatment of packing house wastes was recommended.

A recent in-plant survey has been conducted (January 26 through 29, 1972). At this time Richard Getz, plant superintendent, provided information and assistance.

B. WASTE TREATMENT FACILITIES

The plant is designed for a flow of 2.4 mgd and an influent BOD loading of approximately 6,000 lb/day. The principal components [Figure 1] of this system are:

1. Preliminary treatment -- bar screen, grit chamber, and comminutor;
2. Primary treatment -- two clarifiers (each 60 ft in diameter and 7 ft deep);

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3. Secondary treatment -- two trickling filters, with diameters of 105 ft and 75 ft, respectively (both are 7 ft deep), and two clarifiers (one 55 ft in diameter and 7 ft deep and one 50 ft in diameter and 13.5 ft deep);
4. Disinfection -- chlorine contact chamber (36 ft by 12 ft by 4 ft); and
5. Digestion -- two-stage anaerobic digestion system (each digester is 45 ft in diameter and 28 ft deep), with digested sludge removed to drying beds.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

Three 24-hr composite samples of the influent and effluent (before chlorination) were collected using SERCO automatic samplers and composited on a flow weighted basis from readings obtained at the headworks. A grab sample of the wastewater discharge from the Sterling Beef Packing Company was collected daily in order to provide an estimate of the total load from that waste source. Temperature, pH, and conductivity were measured periodically at all three sampling positions. Grab samples of the municipal plant effluent (after chlorination) were collected periodically for bacteriological analyses and measured for chlorine residual.

The Sterling Beef Company provides primary treatment of wastewater (a clarifier -- 45 ft in diameter by 9 ft deep) prior to discharge into the Sterling wastewater treatment plant. Grease and solids removed by the clarifier are processed by the Company. Grab samples of the packing house effluent showed that the BOD ranged from 910-1800 mg/l [Table 1].

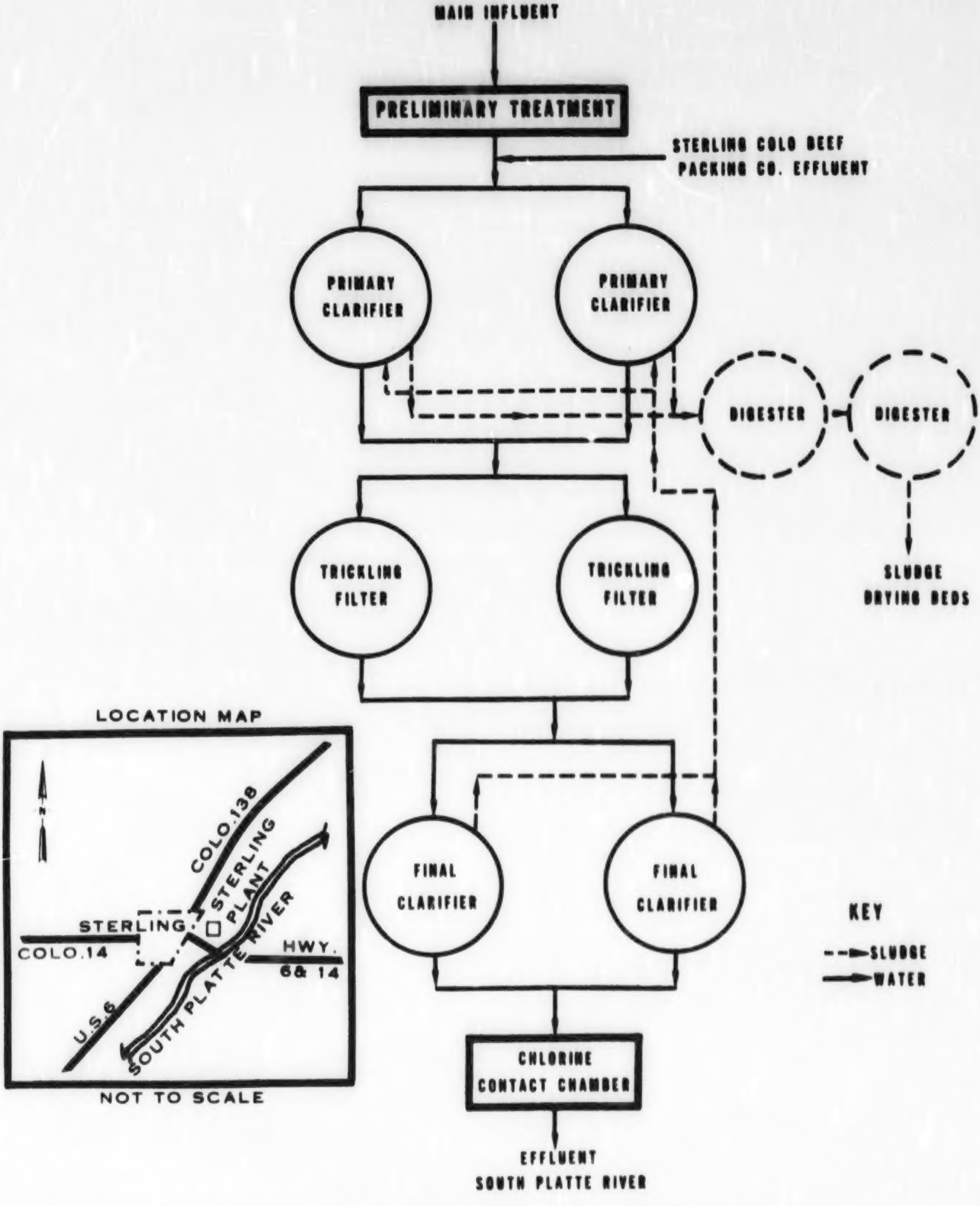
MAIN INFLUENT
PRELIMINARY TREATMENT
STERLING COLO BEEF PACKING CO. EFFLUENT
PRIMARY CLARIFIER
PRIMARY CLARIFIER
DIGESTER
DIGESTER
SLUDGE DRYING BEDS
TRICKLING FILTER
TRICKLING FILTER
LOCATION MAP
N
COLO. 138
STERLING PLANT
STERLING
COLO. 14
HWY. 6& 14
SOUTH PLATTE RIVER
U.S. 6
NOT TO SCALE
FINAL CLARIFIER
FINAL CLARIFIER
KEY
SLUDGE
WATER
CHLORINE CONTACT CHAMBER
EFFLUENT SOUTH PLATTE RIVER

Figure 1. Wastewater Treatment Plant, Sterling

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
STERLING PACKING PLANT, STERLING, COLORADO
JANUARY 26-28, 1972

Parameter[a]	Effluent	
	Range	Average
Flow (mgd)	0.27-0.76	0.49
pH (S.U.)	7.0-8.0	
Temperature (°C)	29.5-40	
Conductivity (μmhos/cm)	1,700-2,200	
BOD (mg/l)	910-1,800	1,270
COD (mg/l)	2,630-2,860	2,750
Total Solids (mg/l)	2,840-4,040	3,550
Suspended Solids (mg/l)	250-1,610	870

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[a] Only grab samples were collected once daily.

The high influent BOD [800-970 mg/l as shown in Table 2] at the Sterling municipal treatment plant indicates that the packing plant contributed the major portion of the organic load.

The organic load (19,000 lbs/day BOD) at the municipal facility was three times the design capacity. Removal efficiencies ranged from 40-82 and 57-95 percent for BOD and suspended solids, respectively. The levels of BOD and suspended solids in the effluent were excessive.

To achieve satisfactory treatment at the municipal plant (i.e. 30 mg/l BOD and suspended solids) the packing plant will need to pretreat its wastes to levels comparable to domestic sewage (250 mg/l).

Disinfection of the effluent was inadequate. Fecal-coliform bacteria densities ranged from 63,000 to 3,000,000/100 ml [Table 3]. The chlorine dosage rate of 50 lb/day (3 mg/l) was not adequate and far below the level recommended by Colorado for adequate disinfection, i.e. 15 mg/l for trickling filter effluents.[2/] At average flow, the detention time in the contact basin was only nine minutes. The State requires a chlorine residual of 1 mg/l after 15 minutes contact time at peak hourly flows.

Laboratory facilities have been provided for the performance of chemical tests of sewage quality. Tests (BOD and settleable solids) are performed daily on the plant influent and effluent and on the Sterling Beef Packing Company effluent. The chlorine residual in the plant effluent is also determined. Additional laboratory analyses should be made to insure efficient operation of the plant.

Routine maintenance at this plant is inadequate (e.g. weirs on clarifiers should be cleaned weekly; bar screens should be kept clean).

TABLE 2

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
STERLING WASTEWATER TREATMENT FACILITY
JANUARY 25-29, 1972

Parameter[a/]	Influent		Effluent		Percent Removal
	Range	Average	Range	Average	
Flow (mgd)			2.29–2.74	2.53	
pH (S.U.)	7.4–7.8		7.3–7.7		
Temperature (°C)	10–20		9.0–16.5		
Conductivity (μmhos/cm)	1,950–2,200		2,000–3,500		
BOD (mg/1)	800–970	903	175–480	288	40–82
COD (mg/1)	1,360–3,070	1,980	458–788	577	42–84
Total Solids (mg/1)	4,110–6,460	5,650	2,520–3,270	2,830	34–61
Suspended Solids (mg/1)	1,200–3,400	2,230	112–512	269	57–95

[a/] Analyses of BOD, COD, total solids, and suspended solids were performed on composite samples.

TABLE 3

BACTERIOLOGICAL RESULTS
STERLING WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
January 26, 1972	0750	1,500,000	95,000	0.0
	0855	2,700,000	280,000	0.0
January 27, 1972	0800	1,600,000	67,000	0.0
	0900	820,000	72,000	0.0
January 28, 1972	0720	870,000	3,000,000	0.1
	0925	710,000	63,000	0.0

D. SUMMARY AND CONCLUSIONS

1. Sterling wastewater treatment plant did not provide adequate BOD removal because of the gross organic overload.

2. The Sterling Beef Packing Company contributes the major portion of the waste load to the Sterling plant.

3. Disinfection of the effluent was inadequate; the chlorine dosage rate and contact time were less than those recommended by the State of Colorado.

4. Laboratory analyses performed are not adequate (i.e. digestor operation).

E. RECOMMENDATIONS

It is recommended that:

1. The chlorine dosage rate be increased to insure adequate disinfection of the effluent (i.e. 1 mg/l after 15 minutes detention); and the contact chamber be enlarged to provide a minimum of 15 minutes detention at peak hourly flow.

2. The Sterling Beef Packing Company provide pretreatment of wastes to such a degree that the wastewater discharged to the Sterling municipal treatment plant does not exceed the strength of normal domestic sewage (250 mg/l each of biochemical oxygen demand and suspended solids).

3. The Sterling wastewater treatment plant be expanded so as to produce an effluent that contains no more than 30 mg/l or 600 lb/day each of biochemcial oxygen demand and suspended solids at design flow, whichever is less.

4. Plant operators be provided training in the operation of the plant by attendance at an operator school and be provided on-the-job training.

F. REFERENCES

1/ *Status of Municipal Waste Treatment in the South Platte River Basin, Colorado, 1964-67*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, December 1967.

2/ *Criteria Used in the Review of Waste Water Treatment Facilities*, Colorado Department of Health, Denver, Colorado, September 1969.

WHEATRIDGE SANITATION DISTRICT
WASTEWATER TREATMENT PLANT
WHEAT RIDGE, COLORADO

A. INTRODUCTION

The Wheatridge Sanitation District treatment facility is located on Clear Creek (RM 311.1/7.7). The facility serves approximately 28,000 people and is staffed by a district superintendent, a plant foreman, three operators, and a secretary. The plant, constructed in 1949, is manned eight hours/day, five days/week, with periodic maintenance checks conducted twice daily on weekends. In 1958, additional trickling filters and secondary clarifiers were built. Total capital cost was $571,000. Annual operating costs during 1970 were approximately $107,000.

An evaluation of this plant was made during the South Platte River Basin studies.[1/] The plant did not provide adequate waste treatment at that time, disinfection was inadequate, and the plant was understaffed.

From February 2 through 5, 1972, an in-plant survey was conducted to ascertain the waste loads discharged and the efficiency of the plant. E. H. Snodgrass, District Superintendent, provided information and assistance during this study.

B. WASTE TREATMENT FACILITIES

The plant has a hydraulic design capacity of 1.8 mgd. Since the time of the South Platte River Basin Project studies the district has connected to the Metropolitan Denver Sewage Disposal District (Metro) plant; as a result, flow in excess of the design flow-capacity can be diverted to Metro.

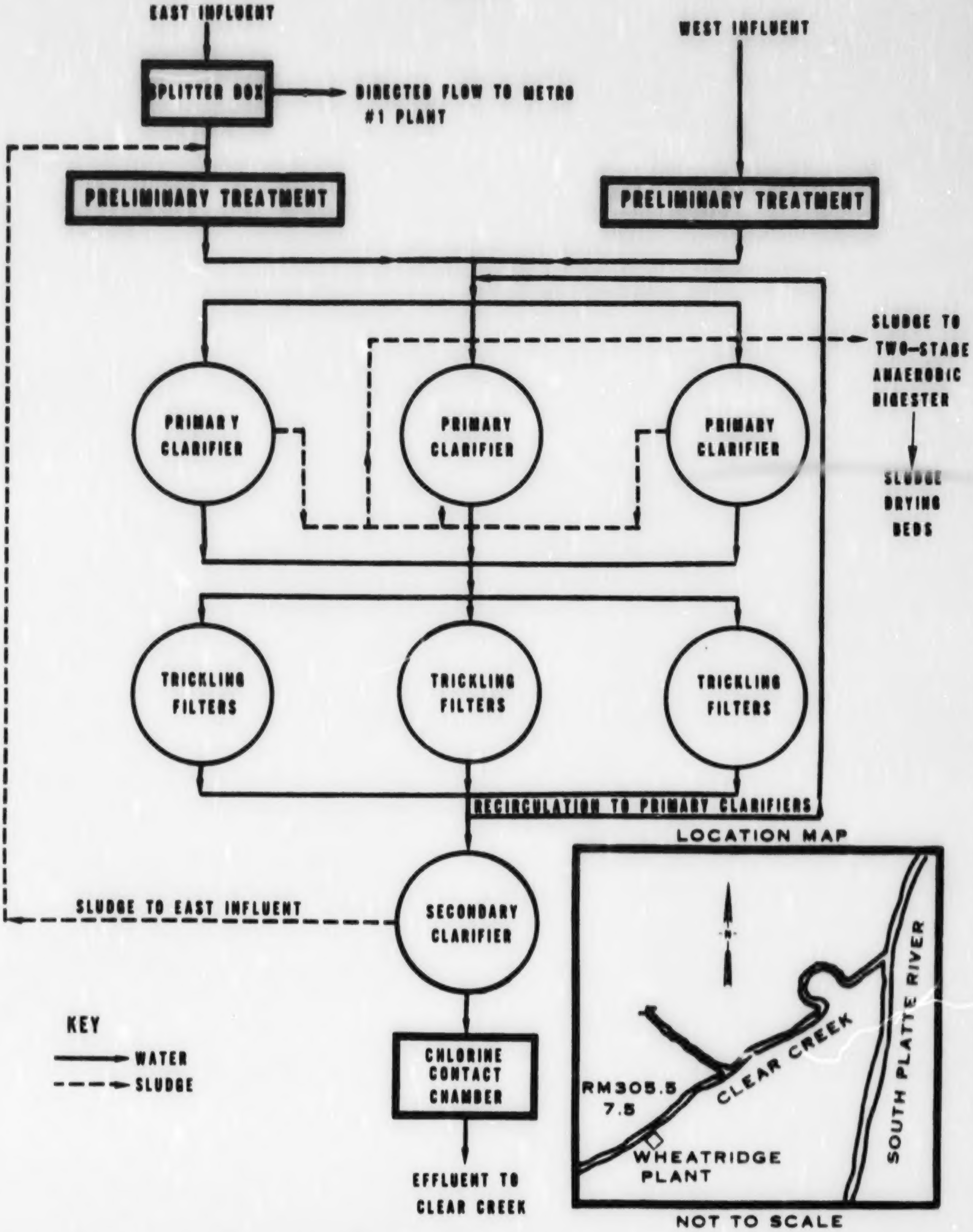
Present treatment facilities [Figure 1] consist of the following:

1. Preliminary treatment -- two bar screens (not used), two grit chambers, and two comminutors, operating in parallel;
2. Primary treatment -- three clarifiers (each 42 ft in diameter and 4 ft side wall depth (SWD));
3. Secondary treatment -- three standard-rate trickling filters (each 100 ft in diameter and 7 1/2 ft in depth), one clarifier 72 ft in diameter, 4 ft SWD;
4. Disinfection -- chlorine contact chamber; and
5. Sludge digestion -- two primary digestion tanks, one secondary tank, and sludge drying beds.

C. DISCUSSION OF PLANT EVALUATION AND FINDINGS

In-plant sampling was conducted February 2 through 5, 1972. Three 24-hr composite samples, collected from both the two influent lines and the effluent, were analyzed for BOD, COD, and solids all before chlorination. Composites were made up from grab samples collected manually each hour and proportioned on the basis of flow measurements (Parshall flume) at the headworks. The pH, temperature, and conductivity were measured at sampling locations. In addition, samples of the effluent after chlorination were analyzed for chlorine residuals and for bacteria densities.

The influent BOD load averaged 6,000 lb/day, or about 15 percent above the influent waste load observed during the 1964 survey (5,300 lb/day).2/ Using a trickling-filter loading rate of 25 lb/1,000 ft^3 the plant has reached its organic loading capacity. The plant discharged


EAST INFLUENT
WEST INFLUENT
SPLITTER BOX
DIRECTED FLOW TO METRO #1 PLANT
PRELIMINARY TREATMENT
PRELIMINARY TREATMENT
SLUDGE TO TWO-STAGE ANAEROBIC DIGESTER
SLUDGE DRYING BEDS
PRIMARY CLARIFIER
PRIMARY CLARIFIER
PRIMARY CLARIFIER
TRICKLING FILTERS
TRICKLING FILTERS
TRICKLING FILTERS
RECIRCULATION TO PRIMARY CLARIFIERS
SLUDGE TO EAST INFLUENT
SECONDARY CLARIFIER
KEY
WATER
SLUDGE
CHLORINE CONTACT CHAMBER
EFFLUENT TO CLEAR CREEK
LOCATION MAP
N
RM305.5
7.5
CLEAR CREEK
SOUTH PLATTE RIVER
WHEATRIDGE PLANT
NOT TO SCALE

ure 1. Wastewater Treatment Plant, Wheatridge Sanitation District to Clear Creek a daily average BOD load of 2,420 pounds and a suspended solids load of 1,540 pounds [Table 1]. Removal efficiencies for these two parameters ranged from 41 to 70 and 28 to 76 percent, respectively. Disinfection was inadequate, as evidenced by the bacterial counts [Table 2]. Plant officials reported that approximately 50 pounds of chlorine were used daily. The recommended dosage rate for chlorination of trickling filter plant effluent is 15 mg/l,[2/] which would require, at design flow rates, addition of about 225 pounds of chlorine daily.

The existing flow meter at the plant did not measure the total flow but only that portion that moved through the east side of the plant. The total flow, measured during the 1972 survey, was found to be 2.15 mgd, or approximately 20 percent in excess of the design capacity. Plant officials reported that, except for brief periods (about 10 minutes) in the morning and evening, no flow is diverted to Metro.

Plant operation and maintenance was considered to be poor and is carried out in a sporadic manner at best. None of the operators hold higher than a Class D certificate, which is the first step in the Voluntary Program of the Colorado Committee for Certification of Water and Sewage Works operators.

D. SUMMARY AND CONCLUSIONS

The Wheatridge Sanitation District plant did not provide adequate secondary treatment or disinfection. The plant was hydraulically overloaded by about 20 percent. The flow in excess of plant capacity (1.8 mgd) was not diverted to Metro although plant officials are permitted to do this. The plant has apparently reached its organic loading capacity.

TABLE 1

SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS
WHEATRIDGE WASTEWATER TREATMENT PLANT
FEBRUARY 2-5, 1972

Parameter[a/]	East Influent		West Influent		Total Influent		Effluent		Percent Removal
	Range	Avg	Range	Avg	Range	Avg	Range	Avg	
Flow (mgd)	1.76-1.85	1.82	0.30-0.36	0.33	2.09-2.21	2.15	2.09-2.21	2.15	
pH (S.U.)	7.4-8.3		7.3-8.3				6.8-7.5		
Temperature (°C)	9-13		9.5-14.0				8.0-12.5		
Conductivity (µmhos/cm)	750-1,700		750-1,100				800-1,400		
BOD (mg/1)	200-540	322	280-493	368			118-162	135	41-70
COD (mg/1)	420-845	610	570-809	665			245-386	303	42-56
Total Solids (mg/1)	598-1,200	847	813-980	872			601-622	611	5-48
Suspended Solids (mg/1)	114-228	167	178-224	199	2,240-4,190	3,080	54-116	87	28-76

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a/ Analyses on BOD, COD, total solids, and suspended solids were performed on composite samples.

TABLE 2

BACTERIOLOGICAL RESULTS
WHEATRIDGE WASTEWATER TREATMENT FACILITY

Date	Time	Total Coliform Count/100 ml	Fecal Coliform Count/100 ml	Chlorine Residual mg/1
February 2, 1972	1530	16,000	50	
February 3, 1972	0900	>80,000	>6,000	0.2
	1230	59,000	92	0.2
	1410	60	4	0.4
February 4, 1972	0905	2,700,000	88,000	0.0
	1400	800,000	>60,000	0.0

Plant operation was poor. Additional operator training is required. The entire flow of this plant could be diverted into the Metro system. This approach would be more suitable than the continued operation of the present facilities.

E. RECOMMENDATIONS

It is recommended that:

1. Operation of the Wheatridge Sanitation District treatment plant be discontinued and all flow be diverted to the Metro system when the additional capacity is available.

2. In the interim, all flows in excess of 1.8 mgd be diverted to Metro, and disinfection practices at the Wheatridge plant be improved so that the density of fecal coliform bacteria in the effluent at no time exceed 1,000/100 ml.

F. REFERENCES

1/ *Municipal Waste Report, Metropolitan Denver Area, South Platte River Basin*, U. S. Department of Health, Education, and Welfare, Public Health Service, Division of Water Supply and Pollution Control, South Platte River Basin Project, Denver, Colorado, December 1965, Appendix B.

2/ *Criteria Used in the Review of Waste Water Treatment Facilities*, Colorado Department of Health, September 1969.